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Influence of macro and micronutrient priming on growth parameter, grain yield and seed quality of soybean

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Abstract
A field study was conducted two consecutive years to know the "Influence of macro and micronutrient priming on growth parameter, grain yield and seed quality of soybean" was carried out during *kharif*, 2018 and 2019 at research farm of Oilseed Research Station, Latur under VNMKV, Parbhani. The experiment was laid out in Randomized Block Design (RBD) with 12 treatments which were replicated thrice. The treatments comprises T_1: absolute control, T_2: Only RDF, T_3: RDF + Zn@ 3g kg^{-1} seed, T_4 :RDF + B @ 3g kg^{-1} seed, T_5: RDF+ Fe @ 3g kg^{-1} seed., T_6: RDF + S @ 3g kg^{-1} seed, T_7: RDF + *Zn* + B each @ 3g/kg^{-1} seed,T_8: RDF + *Zn* + B +Mo each @ 3g kg^{-1} seed,T_9: RDF + *Zn* + B + Mo + Fe each @ 3g kg^{-1} seed,T_{10}: RDF + *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed,T_{11}:RDF + *Rhizobium* +PSB each @ 10 ml kg^{-1} seed,T_{12}: Without RDF + *Zn* + B + Mo + Fe + S each @ 3g kg^{-1} seed. To achieve the objectives the observations were recorded at various growth stages of soybean during 2018 and 2019. The result indicates that, the micronutrient priming treatment T_{10} receiving *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed application along with RDF found to be effective in improving growth and yield attributing characters like germination percentage, plant height, leaf area, root density, number of pods, final plant stand percentages, grain yield, dry matter yield and total biological yield. In grain quality the results revealed that test weight, protein and oil content percentage were significantly influenced with the application of treatment T_{10}.On the other hand, in all the cases the lower response was found from the control treatment.

Keywords: Macronutrient, nutrient, priming, soybean yield, quality

Introduction

Soybeans [*Glycine max* (L.) Merill] are often called the "miracle crop." of the 21st century and has witnessed phenomenal growth in production, processing and trade in last few years in India and has revolutionized the rural economy and improved socio economic status of the farmers. Soybean seed consists of 35 per cent carbohydrate, 5 per cent ash, 40 per cent protein and 20 per cent oil and is a major source of protein and oil for commercial products. In addition, it contains a good amount of minerals, salts and vitamins (thiamine and riboflavin). Soybean improve the soil health and fertility by fixing nitrogen through biological nitrogen fixation in soil which is carried out by symbiotic nitrogen fixing bacteria residing in the root nodule of soybeans (Javaid and Mahmood, 2010) [02]. Soybean also has the capacity to ameliorate the nutritional situation, enhance productivity of other crops. Soybean is the second largest oilseed in India after groundnut. In recent years, soybean has shown a rapid increase in area in southern parts of the country, particularly in the states of Maharashtra, Karnataka. Madhya Pradesh since beginning has been the major contributor to the soybean area and production.

Micronutrients are known to play many complex roles in plant development and health. These include photosynthesis, chlorophyll synthesis, respiration, enzyme function, formation of hormones, metabolic processes, nitrogen fixation, reducing nitrates to usable forms, cell division, development and regulation of water uptake. Micronutrients promote the strong, steady growth of crops that produce higher yields and increase harvest quality maximizing a plant's genetic potential. In particular, their presence can have a great impact on root development, fruit setting and grain filling, seed viability and plant vigor and health.

Normally micro nutrients are provided through different methods like, soil application and foliar spray. But these are expensive and sometime plant roots are unable to absorb. So it is necessary to develop an attractive and easy alternative method to increase the micronutrients availability. One of such method is "Seed nutri priming" The use of macro and micronutrient enriched seeds (seed priming) has been reported to be a better strategy in overcoming macro and micronutrient deficiency. It is one of the physiological methods, which improves seed performance and provide faster and synchronized germination and increase yield and quality improves the crop and increase yield and micronutrient grain contents (Farooq *et al*., 2012) [08] Seed may be treated with micronutrients either by soaking in nutrient solution of a specific duration (seed priming) with micronutrients. In seed priming, seeds are partially hydrated to allow metabolic events to occur without actual germination and re-dries (near to their original weight) to permits routine handling (Bradford 1986) [05], (Farooq *et al*., 2008) [07] Seed priming is employed for better crop stand and higher yields in a range of crops Harris *et al*. (2007) [10]. Small amount of nutrient is required for seed priming hence can be an economical approach as compared with other methods.

Material and Methods

The field experiment was conducted two consecutive years using Soybean crop (Var. MAUS 162) at research farm of Oilseed Research Station, Latur under VNMKV, Parbhani. To study the influence of macro and micronutrient priming on growth parameter, grain yield and seed quality of soybean. After completion of preparatory tillage operations, the experiment was laid out in randomized block design (RBD) with twelve (12) treatments of micro nutrient priming along with RDF replicated three (03) times as per fixed plan and site. Five micronutrient elements i.e. Zinc (*$ZnSO_4$*), Iron *(*$FeSO_4$*)* Boron (H_3BO_3) Elemental sulphur (S), and Ammonium molybdenum (Mo) were used for priming purpose @3g kg^{-1} of seed and bio fertilizer *Rhizobium* + *PSB* 10 ml kg^{-1} of seed. The treatments comprises T_1: absolute control, T_2: Only RDF, T_3: RDF + Zn@ 3g kg^{-1} seed, T_4: RDF + B @ 3g kg^{-1} seed, T_5: RDF+ Fe @ 3g kg^{-1} seed., T_6: RDF + S @ 3g kg^{-1} seed, T_7: RDF + Zn + B each @ 3g/kg^{-1} seed,T_8: RDF + Zn + B +Mo each @ 3g kg^{-1} seed,T_9: RDF + *Z*n + B + Mo + Fe each @ 3g kg^{-1} seed,T_{10}: RDF + *Z*n + B + Mo + Fe+ S each @ 3g kg^{-1} seed,T_{11}:RDF + *Rhizobium* +PSB each @ 10 ml kg^{-1} seed,T_{12}: Without RDF + Zn + B + Mo + Fe + S each @ 3g kg^{-1} seed. One kg each treatment soybean seed taken added 10 to 15 ml of the solution with different concentrations of the micronutrients and micronutrients mixture (nutria priming) for same period of time. Then the seeds were surface washed with distilled spray of water and re-dried with forced air under shade near to original weight to original moisture content soybean

Soybean seed was sown on 24 June 2018 and 30 July 2019 by dibbling method as per randomly replicated plot having size 5.4× 4.5m^2 maintained row to row spacing 45 cm and plant to plant 5 cm and using a seed rate of 65 kg ha^{-1}. All the plots were fertilized with recommended dose of NPK (30:60:30 kg ha^{-1}) whole quantity of fertilizers was applied as a basal dose and micronutrients seed priming done at the time of sowing. After sowing, seed was covered with soil. Sowing depth was kept almost 5 cm. The crop was harvested at maturity stage on 03rd October, 2018 and 4th November 2019. The observation recorded *viz*. plant height, leaf area, root density at flowering, pod formation and at harvest stage The yield attributing parameters *viz*., no. of pods per plant seed yield, fodder yield, total biomass were recorded at harvest stage. Quality parameter like protein, oil content and test weight value were recorded. The data collected from the above observation were analysed statistically by the procedure prescribed by Panse and Sukhatme (1967) [19].

Result and Discussion

Plant height (cm)

Plant height at various growth stages of soybean of two consecutive years 2018 and 2019 expressed in Table 1.It was observed that, among the different nutrient seed priming treatments, plant height of soybean at flowering, pod development and at harvest stage was recorded significantly maximum in treatment T_{10} receiving RDF + *Z*n + B + Mo + Fe+ S each @ 3g kg^{-1} seed and closely followed by treatments T_9 and T_8 in 2018. In the year 2019 treatment T_{10} found maximum plant height at flowering and harvesting stage followed by treatments $T_{4,}$ T_9 and found at par with each other, and at pod development stage of soybean plant height was recorded maximum in treatment T_9 receiving RDF + *Z*n + B + Mo + Fe each @ 3g kg^{-1} seed (57.40 cm plant^{-1}) and it was found at par with treatments $T_{8,}$ T_{10} and $T_{6,}$. While minimum plant height of soybean was recorded in treatment T_1 absolute control in both years. However, the pooled mean data revealed that, priming treatment receiving *Z*n + B + Mo + Fe+ S each @ 3g kg^{-1} seed along with RDF (47.13, 64.93 and 70.40 cm plant^{-1}) recorded highest value of plant height at various growth stages of soybean and followed by treatments $T_{9,}$ $T_{8,}$ $T_{7,}$ $T_{6,}$ $T_3$and T_{11} which

Table 1: Plant height (cm) at various growth stages of soybean as influenced by macronutrients treatments of and priming micronutrients

	Flowering stage			Pod development stage			Harvesting stage		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	49.30	29.93	39.62	65.73	48.73	57.23	73.33	54.40	63.87
T_2	51.40	32.80	42.10	72.13	51.87	62.00	76.47	57.20	66.83
T_3	52.93	33.40	43.17	71.60	50.20	60.90	76.47	58.20	67.33
T_4	51.27	33.00	42.13	72.13	52.73	62.43	76.47	55.27	65.87
T_5	51.00	32.60	41.80	69.87	51.80	60.83	72.93	62.93	67.93
T_6	50.20	34.20	42.20	71.87	53.60	62.73	76.67	60.80	68.73
T_7	54.53	33.53	44.03	71.80	55.73	63.77	77.60	61.40	69.50
T_8	52.87	33.60	43.23	71.20	54.53	62.87	76.13	60.73	68.43
T_9	54.07	33.60	43.83	72.20	57.40	64.80	76.28	61.20	68.74
T_{10}	57.60	36.67	47.13	76.20	53.67	64.93	78.47	62.33	70.40
T_{11}	50.33	34.33	42.33	74.27	50.87	62.57	76.00	60.00	68.00
T_{12}	49.40	31.87	40.63	72.53	52.60	62.57	77.93	55.07	66.50
SE ±	1.398	1.019	0.814	1.607	1.44	1.268	1.087	1.496	0.836
CD at 5%	4.128	2.988	2.389	4.743	4.209	3.719	3.208	4.387	2.453
GM	52.08	33.29	42.68	71.79	52.81	62.30	76.23	59.13	67.68

Were at par with each other at pod development and harvest stage. Whereas, minimum value recorded in T_1 absolute control treatment. It was found that T_{10} had been superior rest of the treatments. However, in pooled mean increment in plant height of soybean was noted up to the extent of 19.86, 13.45 and 10.22 percent at flowering, pod development and harvest stage of soybean respectively in T_{10} over T_1 absolute control. Increase in plant height might be due to cell elongation, cell enlargement and more chlorophyll synthesis resulting in better plant growth due to nutrient seed priming with micronutrients treatment similar findings have been reported by Heidarian *et al.* (2019) [11] and Mahmood, *et al.* (2019) [15].

Root density (g/cm^3): Data in respect of root density at various growth stages of soybean presented in the table 2. There was continuous build up of a root density in soybean with advancing growth stages and found significantly maximum in seed priming treatment T_{10} receiving Zn + B + Mo + Fe+ S each @ 3g kg^{-1} seed along with RDF and followed by treatments T_9, T_8, T_7 and T_9, T_7 at flowering and pod development stage of soybean respectively. While minimum root density of soybean was recorded presented in T_1 in both experimental years as well as pooled mean analysis. Percent increase in root density due to the application RDF and Zn + B + Mo + Fe+ S each@ 3g kg^{-1}seed priming in soybean was noted up to 34.48, 35.00 and 28.88 percent at Flowering, pod development and at harvest stage of soybean. In present investigation smaller results line with Gandhi *et al.* (2017) [9] found maximum root length where boron was used at the lowest concentration Munawar *et al.* (2013) [17] found seed priming with Zn (1.5%) solution. Mn (1.5%) and Mn (2%) solution showed highest mean shoot length and root length in carrot respectively.

Table 2: Root density (g/cm^3) at various growth stages of soybean as influenced by macronutrients and priming treatments of micronutrients

	Flowering stage			Pod development stage			Harvesting stage		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	0.38	0.19	0.29	0.49	0.31	0.40	0.51	0.38	0.45
T_2	0.39	0.23	0.31	0.53	0.34	0.44	0.58	0.42	0.50
T_3	0.40	0.23	0.31	0.53	0.35	0.44	0.59	0.46	0.53
T_4	0.41	0.21	0.31	0.54	0.37	0.46	0.62	0.43	0.52
T_5	0.42	0.23	0.33	0.56	0.36	0.46	0.66	0.47	0.56
T_6	0.41	0.25	0.33	0.56	0.36	0.46	0.60	0.46	0.53
T_7	0.44	0.24	0.34	0.60	0.37	0.48	0.65	0.47	0.56
T_8	0.47	0.26	0.36	0.58	0.38	0.48	0.66	0.49	0.58
T_9	0.44	0.26	0.35	0.59	0.39	0.49	0.66	0.48	0.57
T_{10}	0.51	0.27	0.39	0.67	0.41	0.54	0.66	0.51	0.58
T_{11}	0.48	0.25	0.37	0.65	0.39	0.52	0.66	0.48	0.57
T_{12}	0.44	0.22	0.33	0.55	0.35	0.45	0.61	0.41	0.51
SE ±	0.025	0.013	0.013	0.025	0.016	0.017	0.024	0.022	0.018
CD at 5%	0.075	0.037	0.038	0.075	0.047	0.049	0.070	0.064	0.054
GM	0.43	0.24	0.34	0.57	0.36	0.47	0.62	0.46	67.68

Leaf area (sq. cm per plant)

The data furnished in table 3 revealed that, significantly highest leaf area at flowering, pod development, harvesting stage of soybean was found in the seed priming treatment T_{10} receiving Zn + B + Mo + Fe+ S each @ 3g kg^{-1} seed along with RDF and significantly superior over T_1 absolute control and was found at par with treatments T_3, T_5, T_6, T_7, and T_9. The maximum leaf area at pod development was recorded in the seed priming treatment T_{10} during the year 2018 and 2019 as well as pooled analysis. Micronutrient elements play a critical role in plants that lead to increase of leaf area. The increase in leaf area per plant in present investigation is in accordance with the finding of Dandoti *et al.* (2017) [13] showed coating of linseed seeds with the combination of Zn + B + Mo + Fe+ Ca recorded significantly higher leaf area compared to all other treatments and Badiri *et al.* (2014) [3] who reported priming the plantain seeds with Zn, Mn and Fe significantly increased leaf area.

Table 3: Leaf area (sq. cm per plant) at various growth stages of soybean as influenced by macronutrients and priming treatments of micronutrients

Tr.	Flowering stage			Pod development stage			Harvesting stage		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	361.60	244.67	303.13	539.33	388.00	463.67	269.47	145.00	207.23
T_2	469.93	307.33	388.63	640.53	416.67	528.60	306.07	166.00	236.03
T_3	531.00	354.67	442.83	694.60	441.67	568.13	375.07	219.00	297.03
T_4	503.47	318.00	410.73	684.80	413.33	549.07	347.47	210.67	279.07
T_5	524.67	327.67	426.17	693.67	420.00	556.83	391.20	214.33	302.77
T_6	537.60	353.67	445.63	730.67	473.67	602.17	395.87	244.67	320.27
T_7	534.53	348.33	441.43	701.87	453.67	577.77	379.67	241.00	310.33
T_8	551.67	410.33	481.00	742.67	494.33	618.50	405.47	245.00	325.23
T_9	565.73	387.33	476.53	810.53	512.67	661.60	395.87	251.67	323.77
T_{10}	651.47	440.67	546.07	923.67	521.00	722.33	427.60	258.33	342.97
T_{11}	526.80	410.67	468.73	714.67	485.33	600.00	349.60	235.67	292.63
T_{12}	481.53	295.33	388.43	624.60	401.33	512.97	338.13	158.67	248.40
SE ±	10.489	23.880	14.651	19.387	23.158	16.875	19.783	18.505	14.110
CD at 5%	30.961	70.036	42.969	57.227	67.921	49.491	58.397	54.272	41.384
GM	520.00	349.89	434.94	708.47	451.81	580.14	365.12	215.83	290.48

No. of pods per plant

It is evidenced from the data presented in table 4.Among the various treatments seed priming with micronutrients treatment T_{10} (57.73, 32.87 and 45.20) receiving *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed along with RDF registered the more number of pods per plant at harvest stages of soybean and found significantly superior over rest of all treatment and at par with treatments. T_9, T_8, T_7, T_6, and T_{11}.Whereas less number of pods per plant was noticed in treatment T_1 (38.80, 18.60 and 28.70) receiving absolute control respectively in both years and pooled analysis. However, increment was noted up to the extent of 57.49 percent with regards to number of pods per plant in T_{10}. During the growth stage, plants were highly affected by micronutrient applications which directly become visible at pods initiation and forming. Our result corresponds to the findings of Harris *et al*., (2008) [10] Ali *et al*. (2018) [18] Barangule. *et al*. (2018) [4].

Table 4: No of pods, Weight of pods per plant (gm) and final plant stand percentage at harvest stages of soybean as influenced macronutrients and priming treatments of micronutrients

Tr.	No of pods			Weight of pods			Final plant stand (%)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	38.80	18.60	28.70	13.00	9.67	11.33	79.55	79.32	79.43
T_2	45.80	20.40	33.10	13.53	11.20	12.37	84.28	85.95	85.11
T_3	47.87	24.20	36.03	15.87	11.67	13.77	89.51	88.14	88.83
T_4	49.47	23.67	36.57	15.80	12.13	13.97	86.48	87.65	87.06
T_5	48.67	25.80	37.23	16.53	13.40	14.97	90.30	92.77	91.53
T_6	54.73	26.67	40.70	15.80	13.93	14.87	88.67	92.42	90.55
T_7	51.27	29.53	40.40	16.13	14.07	15.10	87.99	91.36	89.68
T_8	54.33	28.60	41.47	17.00	13.33	15.17	88.98	92.20	90.59
T_9	55.13	29.13	42.13	17.27	14.53	15.90	87.95	91.33	89.64
T_{10}	57.73	32.67	45.20	18.20	15.13	16.67	90.64	93.90	92.27
T_{11}	50.73	27.67	39.20	15.33	13.80	14.57	86.97	92.80	89.89
T_{12}	44.80	22.40	33.60	13.20	10.93	12.07	82.88	84.17	83.52
SE ±	2.702	2.199	1.665	0.947	0.914	0.662	1.894	1.492	1.289
CD at 5%	7.976	6.450	4.885	2.794	2.681	1.941	5.555	4.377	3.780
GM	49.94	25.78	37.86	15.64	12.82	14.23	87.02	89.33	88.18

Weight of pods per plant (gm)

The data pertaining to weight of pods per plant at harvest stages of soybean presented in table 4. It was observed that in the year 2018 and 2019 and in pooled analysis weight of pods per plant at harvest stages of soybean was found significantly highest in treatment T_{10} (18.20, 15.13 and 16.67 gm) receiving RDF + *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed priming and followed by treatments T_9,T_8,T_7,T_6, and T_5 and at par with each other. While lowest value of weight of pods per plant was recorded in treatment T_1 (13.00, 9.67 and 11.33 gm) absolute control respectively. This might be due to fact that the combined application of micronutrients along with RDF in primed manner had increased weight of pods per plant at harvest stage. Similar results were also observed by Kalpana *et al.* (2013) [14] Dandoti *et al.* (2017) [13].

Final plant stands percentage

It is evidenced from the data two consecutive years and pooled data expressed in table 4. The treatment T_{10} (90.64, 93.90 and 92.27 per cent) receiving RDF + *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed priming recorded maximum final plant stand percentage and was significantly superior over rest of all treatment and it was found at par with treatments T_9,T_8,T_7,T_6,T_5,T_4,$T_{11}$and T_3.Whereas minimum value of final plant stand percentage was recorded in treatment T_1 (79.55, 79.32 and 79.43 per cent) absolute control respectively. The increase in final plant stand percentage with nutrient seed dressing with micronutrients observed in the present study was in the accordance with the findings reported by Farooq *et al*. (2012) [8] Dandoti *et al.* (2017) [13] Sale and Nazirkar (2013) [22].

Grain yield (q ha^{-1})

The data related to grain yield at harvest stage of soybean narrated in table no. 5. During the year 2018, 2019 and pooled analysis the grain yield of soybean significantly influenced by various treatments. Among the treatments evaluated, the seed priming with combined micronutrient along with RDF (30:60:30 NPK Kg ha^{-1}) treatment T_{10} receiving *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed, produced maximum grain yield (21.21, 12.07 and 16.64 q ha^{-1}) which was significantly superior over T_8 (19.68,10.78 and 15.23 q ha^{-1}),T_9 (19.62,10.99 and 15.31 q ha^{-1}), T_6 (19.22,11.06 and 15.14 q ha^{-1}), T_5 (19.42,10.89 and 15.15 q ha^{-1}) and T_3 (19.74, 10.56 and 15.15 q ha^{-1}) further it was observed that the seed treatment T_{10} recorded at par yield with T_8, T_9 T_7, T_6 T_5 and T_3 and found significantly superior over T_1 (16.44, 8.87 and 12.66 q ha^{1}) and noticed lowest seed yield of soybean in T_1 absolute control. Per cent increase in grain yield of soybean due to the micronutrient priming *Zn* + B + Mo + Fe+ S each @ 3g kg^{-1} seed along with RDF was noted up to 29.01,36.07 and 31.43 per cent in the years 2018, 2019 and pooled data respectively. Combination of micronutrients like Iron, zinc, boron sulphur and molybdenum gives maximum seed

Table 5: Grain yield, dry matter yield and total biological yield (q ha^{-1}) at harvest stages of soybean as influenced macronutrients and priming treatments of micronutrients

Tr.	Grain yield			Dry matter yield			Total biological yield		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	16.44	8.87	12.66	15.45	8.38	11.92	31.89	17.25	24.57
T_2	17.88	9.40	13.64	16.75	9.17	12.96	34.63	18.57	26.60
T_3	19.74	10.56	15.15	17.17	9.86	13.51	36.91	20.41	28.66
T_4	18.68	9.60	14.14	16.47	9.00	12.74	35.16	18.60	26.88

T_5	19.42	10.89	15.15	17.73	9.48	13.61	37.15	20.37	28.76
T_6	19.22	11.06	15.14	18.26	9.55	13.90	37.48	20.60	29.04
T_7	18.09	10.02	14.06	16.79	9.84	13.32	34.88	19.87	27.37
T_8	19.68	10.78	15.23	18.08	10.70	14.39	37.76	21.48	29.62
T_9	19.62	10.99	15.31	18.17	10.56	14.36	37.79	21.55	29.67
T_{10}	21.21	12.07	16.64	20.10	11.29	15.69	41.31	23.36	32.33
T_{11}	18.72	10.09	14.41	18.12	9.68	13.90	36.84	19.78	28.31
T_{12}	17.28	9.32	13.30	16.25	9.98	13.11	33.53	19.30	26.42
SE ±	0.743	0.466	0.369	0.756	0.705	0.481	1.101	0.659	0.574
CD at 5%	2.194	1.366	1.084	2.232	2.069	1.411	3.250	1.932	1.683
GM	18.83	10.30	14.57	17.44	9.79	13.62	36.28	20.09	28.19

Yield as compared to all other treatments due to synergistic effect of these micronutrients. Which are the metallic components of one or more enzymes which are involved in various physiological functions, growth, development and crop productivity. These results are also in accordance with Pawel (2013) [20] in soybean, Barangule *et al*. (2018) [4] in sorghum, Muhammad Imran (2015) [12] in maize.

Dry matter yield (q ha^{-1})

The data expressed in table 5. The dry matter yield of soybean significantly influenced and the highest value of dry matter yield was recorded in treatment T_{10} receiving RDF + *Z*n + B + Mo + Fe+ S each @ 3g kg^{-1} seed (20.10, 11.29 and 15.69 q ha^{-1}) seed priming and found significantly superior over rest of all treatment respectively and also found at par with treatments T_9, T_8, and T_{11} in year 2018 and pooled data as well as T_9, T_8, T_7, T_{11}, T_6 and T_3 in year 2019. Whereas lowest value of dry matter yield of soybean was observed in treatment T_1 absolute control (15.45, 8.38 and 11.92 q ha^{-1}) respectively in both years and pooled analysis. The magnitude of increase dry matter yield of soybean with T_{10} was improved to the tune of 31.62 per cent over absolute control T_1.

Total biological yield (q ha^{-1})

Total biological yield of soybean was tabulated in table 5. Total biological yield of soybean obtained with the application of the treatment T_{10} receiving RDF + *Z*n + B + Mo + Fe+ S each @ 3g kg^{-1} seed (41.31, 23.36 and 32.33 q ha^{-1}) and at par with the treatment T_9, T_8, T_7, T_6, T_5, T_3 and T_{11} in year 2018 and the treatment T_{10} was found superior all over rest of all treatment in 2019 whereas T_1 absolute control was recorded lowest value (31.89,17.25 and 24.57qha^{-1}) during both the years of experimentation as well as in pooled analysis. However, in pooled data mean increment was noted up to the extent of 31.58 percent with regards to total biological yield of soybean in T_{10}. These results also coincide with the finding of Badiri *et al*. (2014) [3] who reported that total biomass significantly increased due to seed priming with Zn, Fe, Mn. and. Arif *et al*. (2007) [1] also reported that seed priming in zinc solution significantly affected biological yield of wheat and chickpea.

Test weight of 1000 seeds (gm)

Data on test weight value of 1000 seeds (gm) at harvest stages of soybean presented table 6. During experimental year, test weight value of 1000 seeds (gm) of soybean recorded highest (133.67, 130.33 and 132.00 gm) in seed priming treatment T_{10} receiving RDF + *Z*n + B + Mo + Fe+ S each @ 3g kg^{-1} seed and followed by T_9, T_8, T_7, T_6, T_4 and T_3 in the year 2018 as well as T_9, T_8 and T_{11} treatment in the year 2019 and pooled data. However the lowest test weight of seed was observed in treatment T_1 absolute control (120.00, 118.33 and 119.17 gm) respectively and the magnitude of increase in test weight 1000 seeds (gm) of soybean with T_{10} was increased to the tune of 10.02 per cent. These results are in conformity with the findings of Arif *et al*. (2007) [1] who reported that seed priming increased thousand grain weights in chickpea. Greater mobilisation of photosynthes to the developing seeds by application of micronutrients might be the reason for increase in seed weight.

Protein content (per cent)

The data on protein content percentage of soybean grain recorded statistically significant expressed in table 6. In both the years and pooled data percentage protein content in soybean significantly observed highest due to application RDF and Zn + B + Mo + Fe+ S each @ 3g kg^{-1} seed priming (38.73, 38.49 and 38.61%) and significantly superior over rest of all treatment and at par with all treatment except T_1 and T_{12} and lowest was noticed in treatment T_1 absolute control (27.91, 30.90 and 29.14 per cent) respectively and magnitude of increase in protein content of soybean with T_{10} was increased to the tune of 31.28 per cent over absolute control. Increase in protein content might be due to combined priming of micronutrients which involved protein synthesis and there by increased protein content. Our results corresponds to the findings of Sarker *et al*. (2002) [23] Mirshekari *et al*. (2012) [16] and Rehman *et al*. (2012) [21] who reported priming enhanced buildup of nucleic acid, enhanced synthesis of protein.

Table 6: Test weight (1000 seeds), protein content (percent) and oil content (per cent) at harvest stages of soybean as influenced macronutrients and priming treatments of micronutrients

Tr.	Test weight (1000 seeds)			Protein content (percent)			Oil content (per cent)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	120.00	118.33	119.17	27.91	30.90	29.41	15.76	14.92	15.34
T_2	120.33	122.67	121.50	35.36	33.85	34.61	14.25	14.51	14.38
T_3	126.00	123.67	124.83	38.73	36.37	37.55	15.22	15.20	15.21
T_4	126.33	124.67	125.50	33.83	32.42	33.13	15.51	15.45	15.48
T_5	125.33	124.33	124.83	37.71	36.30	37.01	14.84	15.10	14.97
T_6	126.33	124.67	125.50	36.69	37.80	37.25	15.55	15.87	15.71
T_7	131.33	124.00	127.67	37.92	37.93	37.92	15.64	15.75	15.70
T_8	128.33	125.67	127.00	38.63	36.95	37.79	15.30	15.74	15.52
T_9	130.67	127.67	129.17	37.81	33.51	35.66	15.62	15.77	15.70
T_{10}	133.67	130.33	132.00	38.73	38.49	38.61	16.02	16.38	16.20

T_{11}	125.67	128.00	126.83	36.39	35.32	35.85	14.35	14.67	14.51
T_{12}	123.33	120.67	122.00	27.98	32.00	29.99	15.62	15.32	15.47
SE ±	2.705	1.817	1.314	2.068	1.261	1.427	0.324	0.249	0.254
CD at5%	7.985	5.330	3.855	6.065	3.699	4.186	0.956	0.732	0.744
GM	126.44	124.56	125.50	35.64	35.15	35.40	15.31	15.39	15.35

Oil content (per cent)

It is evidenced from the data presented in table 6. Oil content (per cent) soybean grain was found maximum in the seed priming treatment T_{10} (16.02,16.38 and 16.20 per cent) receiving RDF + Zn + B + Mo + Fe+ S each @ 3g kg^{-1} seed application was significantly superior over rest of all treatment and at par with treatments T_6,T_9,T_8, and T_7. While oil content (per cent) soybean grain was recorded lowest in treatment T_2 (14.25,14.51 and 14.38 per cent) receiving only RDF respectively in both year as well as pooled analysis. Due to dilution effect treatment T_1 absolute control higher value than T_2 receiving only RDF. However, increment was noted up to the extent of 12.65 percent with regards to oil content (per cent) in soybean grain in T_{10} over T_1 absolute control. The increase in oil content with sulphur application might be due to the fact that sulphur helped in oil synthesis by enhancing the level of thioglucosides Dwivedi and Bapat, (1998) [6]. The results are in conformity with the findings of Tahir *et al.* (2014) [24] these results are also in accordance with Pawel (2013) [20] in soybean.

Conclusion

It can be inferred and concluded that seed nutrient priming of micronutrient Zn + B + Mo + Fe+ S each @ 3g kg^1seed with recommended dose of

NPK (30:60:30 kg ha-1) to soybean improved growth attributes, yield attributes and quality. So, seed nutrient priming is an attractive and easy alternative in supplying the micronutrient requirement to crops in time.

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