International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2694-2698

Received: 14-05-2018
Accepted: 20-06-2018

Qasimullah Ryan
Department of Agronomy, University of Agricultural Science, GKVK, Bengaluru, Karnataka, India

KN Geetha
Department of Agronomy, University of Agricultural Science, GKVK, Bengaluru, Karnataka, India

AG Shanker
Department of Crop Physiology, University of Agricultural Science, GKVK, Bengaluru, Karnataka, India

Correspondence
Qasimullah Ryan
Department of Agronomy, University of Agricultural Science, GKVK, Bengaluru, Karnataka, India

Effect of organic manures and super absorbent polymers on nutrients uptake and economics of soybean [*Glycine max* (L.) Merrill]

Qasimullah Ryan, KN Geetha and AG Shanker

Abstract
The effect of organic manures and super absorbent polymers on nutrients uptake and economics of soybean [*Glycine max* (L.) Merrill] was studied with eight different treatments replicated thrice with Randomized Completely Block Design (RCBD). The treatments were comprising of RDF alone, RDF with FYM at the rate of 3.0 t ha^{-1}, RDF plus potassium polyacrylate @ 5.0, 7.5 and 10.0 kg ha^{-1}, RDF plus pusa hydrogel @ 7.5 kg per hectare, RDF plus humic acid @ 3.0 kg ha^{-1} and RDF plus vermicompost at the rate of 3.0 t ha^{-1}. The results revealed that, application of RDF along with potassium polyacrylate at 7.5 kg ha^{-1} was recorded to be significantly higher with respect to growth *viz*., plant height, number of leaves plant^{-1}, total dry matter and yield parameters like seed weight plant^{-1}, test weight, oil per cent and oil yield. The uptake of NPK and S was also recorded higher with above said treatment. Net returns and B:C ratio was higher with application of potassium polyacrylate at 7.5 kg ha^{-1} along with RDF.

Keywords: Soybean, RDF, organic manures, super absorbent polymer

Introduction
Soybean is a rich source of nutrition. From nutritional point of view, it is called as miracle bean. It contains about 40 per cent protein, well balanced amino acids, 20 per cent oil rich with poly unsaturated fatty acids, specially Omega 6 and Omega 3 fatty acids, 6-7 per cent total mineral, 5-6 per cent crude fibre and 17-19 per cent carbohydrates (Chauhan *et al*., 2005) [8]. It is an environment friendly grain legume and has now become a major source of protein, oil and health promoting phyto-chemicals for human nutrition and livestock feed around the globe. It is the leading source of edible oils constituting about 30 per cent of the world supply. Soybean cultivation improves soil health because of its atmospheric nitrogen fixing ability and deep root system. Symbiotically soybean fixes 125-150 kg N ha^{-1} and leaves about 30-40 kg N ha^{-1} for succeeding crop. In India, it is grown over an area of 9.60 m ha with production of 9.70 m t and productivity of 983 kg ha^{-1}. The major soybean producing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Telangana, Karnataka and Gujarat. In Karnataka, soybean occupies in an area of 0.15m ha with production of 0.09 m t and productivity of 675 kg ha^{-1} (Anon., 2016) [3, 5]. Drought stress is one of the major abiotic stresses in agriculture worldwide. Erratic rainfall and soil moisture deficiency causes yield losses in soybean. For mitigation of such problems water saving materials are needed. For maintenance and sustaining of soil fertility and crop productivity in dryland areas, the use of organic manures and super absorbent polymers are very important. Organic manures like Farmyard manure and vermicompost increase the organic matter content in soil, therefore improving the cation exchange capacity of the soil, increasing soil water retention capacity, promoting soil aggregates stability and buffering the soil against the toxicity and toxic heavy metals (Rachana *et al*., 2014) [15]. Humic acid is an organically charged bio-stimulant. It has been extensively investigated that humic acid improves physical, chemical and biological properties of soil resulting in improved soil health, mineral availability and nutrient uptake by plants. Humic acid based organic manures increase crop yield and improve soil fertility in an ecologically and environmentally good manner (Rajpar *et al*., 2011) [16]. Hydrogel (Super absorbent polymer) is a water retaining, cross-linked hydrophilic and biodegradable amorphous polymer which can absorb and retain water at least 400 times of its original weight and make at least 95 per cent of stored water available for crop absorption (Johnson and Veltkamp, 1985) [13].

Material and Methods

The experimental investigation was conducted during *kharif* 2017 at Zonal Agricultural Research Station (ZARS), All India Coordinated Research Project (AICRP) on soybean, University of Agricultural Sciences (UAS), GKVK, Bengaluru to study the efficacy of organic manures and super absorbent polymers on moisture retention and productivity of soybean [*Glycine max* (L.)]. The soil was red sandy loam with pH 6.23, EC 0.14 and available NPK and S (276.8, 47.5, 271.5 kg ha-1, and 11.15 ppm, respectively). The experiment was consisting eight treatments replicated trice with RCBD design. The organic manures and super absorbent polymers were applied at furrows along with RDF (25-60-25 kg N-P_2O_5-K_2O /ha) and seeds in time of sowing. The total rainfall received during the year 2017 was 1111 mm. The highest rainfall (275.6 mm) was received in September and the lowest (1.6 mm) in April. During crop growth period (August to November) total rainfall received was 748.5 mm, the highest actual rainfall received during crop growth period was 275.6 mm against the normal rainfall of 193.3 mm. the actual mean maximum monthly temperature (28.2 °C) was higher compared to normal (26.9 °C), during crop growth period. The observations were recorded for growth and yield parameters, NPK and S uptake. NPK and S was estimated by Alkaline permanganate method (Subbiah and Asija, 1956) [21], Olsen's method (Jackson, 1973) [12], Neutral normal ammonium acetate method (Jackson, 1973) [12] and Turbidometric method (Jackson, 1973) [12]. Economics were calculated based on the prevailing market price of the area. The oil content of the soybean seed was estimated by using Nuclear Magnetic Resonance (NMR model mimispec 20 pi) technique and oil yield per hectare was computed by multiplying oil content of respective treatment into seed yield and divided by hundred.

Results and Discussion

Growth Parameters

The effect of organic manures and super absorbent polymers on plant height, number of plant^{-1} and total dry matter of soybean is tabulated in Table 1. Variation in plant height was 55.0 t 74.6 cm at harvesting. Plant height reflects the vegetative growth behaviour of the plant to applied nutrients and soil moisture. Higher plant height was observed between 60 and at harvest. The data clearly showed that the treatment having RDF plus potassium polyacrylate at 7.5 kg ha^{-1} resulted in higher plant height of soybean at all growth stages. This might be attributed to rapid meristematic cell division and cell elongation, adequate soil moisture and nutrients availability due to presence of RDF and potassium polyacrylate. The number of leaves plant^{-1} was also recorded more with the said treatment. The variation in the number of leaves plant^{-1} was from 19.63 to 31.35 at 60 DAS. Plant height and number of leaves was increased due to high retention of moisture in soil and nutrients availability in the root zone of the crop, where it might have helped to enhance the activity of cell, causing increment in plant height and number of leaves per plant. The result is in conformity with the result of Al-Harbi *et al*., (1999) [2] in cucumber and Anon., (2016) [3, 5] in maize. Dry matter production of soybean gradually increased the age of the crop. The plots applied with RDF plus potassium polyacrylate at 7.5 kg ha^{-1} produced higher dry matter than rest of the treatments. The variation in dry matter production was 41.0 to 57.3 g plant^{-1} at harvesting. Better utilization of resources and light interception in plant increase the total dry matter production. In present investigation dry matter production increased from 30 DAS to harvest with application of organic manure and super absorbent polymers in soybean. El-Salmawi (2007) [10] shown that increased dry matter was due to increase in protein, carbohydrate and amino acid especially in the application of super absorbent polymers. Likewise, a significant increase in production of total dry matter due to super absorbent polymers was revealed by Silberbush *et al*., (1993) [19] in maize, Wang *et al.*, (2001) [22] in canola, Akhter *et al*., (2004) [1] in barley and wheat, Yazdani *et al*., (2008) [24] in soybean and Atiyeh and Ebrahim, (2013) [7] in *Pranus cerusifera*. Most of the growth parameters of soybean were increased with application of potassium polyacrylate at 7.5 kg per hectare along with RDF. This might could be due to appropriate soil moisture and nutrients specially potassium availability in the root zone of the plant, which tend to increase all the growth parameters. The results are in agreements with the results of Atiyeh and Ebrahim, (2013) [7].

Table 1: Effect of organic manures and super absorbent polymers on plant height, number of leaves per plant and total dry matter of soybean

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Total dry matter (g plant^{-1})
T_1: RDF (25-60-25 kg N, P_2O_5, K_2O ha^{-1})	55.0	19.63	41.0
T_2: RDF + 3.0 t FYM ha^{-1}	60.1	23.55	45.7
T_3: RDF + Potassium polyacrylate @ 5.0 kg ha^{-1}	63.0	25.21	48.3
T_4: RDF + Potassium polyacrylate @ 7.5 kg ha^{-1}	74.6	31.35	57.3
T_5: RDF + Potassium polyacrylate @ 10.0 kg ha^{-1}	71.6	29.50	52.7
T_6: RDF + Pusa Hydrogel @ 7.5 kg ha^{-1}	68.5	26.60	49.8
T_7: RDF + Humic acid @ 3.0 kg ha^{-1}	65.4	25.80	48.8
T_8: RDF + Vermicompost @ 3.0 t ha^{-1}	70.9	26.60	50.0
S. Em ±	1.6	1.71	0.44
CD (P=0.05)	4.9	5.18	4.69

Note: RDF: Recommended Dose of Fertilizer; **DAS:** Days After Sowing; **FYM:** Farm Yard Manure.

Yield and quality parameters

The data pertaining to yield and quality parameters are present in Table 2. Significantly higher seed weight per plant (28.62 g) was recorded with application of RDF along with potassium polyacrylate at 7.5 kg per hectare compared to other treatments. This was followed by T_5 (RDF + Potassium polyacrylate @ 10.0 kg ha^{-1}) (22.76 g). Among all the treatments, significantly higher 100 seed weight (19.07 g) was recorded with application of potassium polyacrylate at the rate of 7.5 kg ha^{-1} along with RDF (25-60-25 kg N, P_2O_5, K_2O ha^{-1}). This was followed by T_5 (RDF + Potassium polyacrylate @ 10.0 kg ha^{-1}) having the value of 18.89 g. Statistically lower 100 seeds weight (15.86 g) was recorded in treatment where only RDF was used. The higher yield and yield attributes for these treatments over control in present investigation could be due to increased growth and

physiological parameters as well as biomass per plant as a result of sufficient availability of water, balanced K availability in the root zone of crop and indirectly nutrients supply to the crop under water stress condition, which in turn leads to better translocation of nutrients, water and photo assimilates and eventually increased the yield attributing parameters. The similar results were recorded by Sivapalan (2006) [20] in soybean, Yazdani *et al*., (2007) [23] in soybean and Mondal (2011) [14] in pigeon pea. The oil content in soybean was not influenced significantly by the application of organic manures and super absorbent polymers. The data is presented in Table 2. The higher oil content of soybean seed (19.8 %) and significantly higher oil yield (534.9 kg ha^{-1}) was recorded with application of RDF + Potassium polyacrylate @ 7.5 kg ha^{-1} compared to all other treatments and comparatively lower oil content (19.4 %) and oil yield (391.7 kg ha^{-1}) was recorded in treatment where recommended dose of fertilizer was applied alone. The oil content in soybean seeds depends on its genetical potential therefore, it was not significantly influenced by the treatments. Similar results were also reported by Godavari *et al*., (2017) [11].

Table 2: Effect of organic manures and super absorbent polymers on seed weight per plant, 100 seeds weight, oil content and oil yield of soybean

Treatments	Seed weight plant^{-1} (g)	100 seeds weight (g)	Oil content (%)	Oil yield Kg ha^{-1}
T_1:RDF (25-60-25 kg N, P_2O_5, K_2O ha^{-1})	11.43	15.86	19.4	391.7
T_2:RDF + 3.0 t FYM ha^{-1}	14.27	16.67	19.8	455.9
T_3:RDF + K polyacrylate @ 5.0 kg ha^{-1}	18.09	17.33	19.3	451.6
T_4:RDF + K polyacrylate @ 7.5 kg ha^{-1}	28.62	19.07	19.8	534.9
T_5:RDF + K polyacrylate @ 10.0 kg ha^{-1}	22.76	18.89	19.8	532.8
T_6:RDF + Pusa Hydrogel @ 7.5 kg ha^{-1}	19.84	17.87	19.5	486.9
T_7:RDF + Humic acid @ 3.0 kg ha^{-1}	19.10	17.50	19.5	472.9
T_8:RDF + Vermicompost @ 3.0 t ha^{-1}	21.47	18.00	19.7	524.9
S. Em ±	0.997	0.51	0.20	20.81
CD (P=0.05)	3.024	1.53	NS	63.13

Note: RDF: Recommended Dose of Fertilizer; **DAS:** Days After Sowing; **FYM:** Farm Yard Manure; **NS:** Non-significant

Nutrients Uptake

The data recorded on uptake of nitrogen, phosphorous, potassium and sulphur at harvest of the crop as influenced by application of organic manures and super absorbent polymers are presented in the Table 3. Total uptake of nitrogen in soybean was significantly influenced with the application of organic manures and super absorbent polymers. Significantly higher nitrogen uptake was with application of RDF + Potassium polyacrylate @ 7.5 kg ha^{-1} (217.9 kg ha^{-1}). This was followed by RDF + Potassium polyacrylate @ 10.5 kg ha^{-1} (207.3 kg ha^{-1}). In case of RDF alone lower nitrogen uptake (165.9 kg ha^{-1}) was recorded. The total uptake of the phosphorus in soybean was significantly higher with application of RDF + Potassium polyacrylate @ 7.5 kg ha^{-1} (29.89 kg ha^{-1}) compared to other treatments and it was followed by RDF + Potassium polyacrylate @ 10.5 kg ha^{-1} (28.56 kg ha^{-1}). The treatment with RDF alone showed less phosphorus uptake (19.22 kg ha^{-1}). Total uptake of the potassium was significantly higher under the treatment having RDF + Potassium polyacrylate @ 7.5 kg ha^{-1} (195.4 kg ha^{-1}) compared to other treatments. Treatment having RDF + Potassium polyacrylate @ 10.5 kg ha^{-1} was next in the order (194.9 kg ha^{-1}). Less potassium uptake (156.5 kg ha^{-1}) was found in the RDF alone. The total uptake of the sulphur in soybean was significantly higher with application of RDF + Potassium polyacrylate @ 7.5 kg ha^{-1} (28.46 kg ha^{-1}) compared to other treatments. It was followed by RDF + Potassium polyacrylate @ 10.5 kg ha^{-1} (27.92 kg ha^{-1}). The treatment having RDF alone showed less sulphur uptake (18.05 kg ha^{-1}). The increment in nutrient uptake by soybean might be due to increased soil moisture content as a result of application of super absorbent polymer and organic manures. The results are in agreement with the results of Anter and De Boodt (1976) [6], El-Hady *et al*. (1981) [9] and Rifat and Safdar (2004) [17].

Table 3: Effect of organic manures and super absorbent polymers on NPK and S uptake of soybean

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})
T_1:RDF (25-60-25 kg N, P_2O_5, K_2O ha^{-1})	165.9	19.22	156.5	18.05
T_2:RDF + 3.0 t FYM ha^{-1}	180.99	21.38	169.5	20.77
T_3: RDF + K polyacrylate @ 5.0 kg ha^{-1}	185.9	23.11	175.5	21.84
T_4: RDF + K polyacrylate @ 7.5 kg ha^{-1}	217.9	29.89	195.4	28.46
T_5: RDF + K polyacrylate @ 10.0 kg ha^{-1}	207.3	28.56	194.9	27.92
T_6: RDF + Pusa Hydrogel @ 7.5 kg ha^{-1}	193.1	25.08	180.7	24.47
T_7: RDF + Humic acid @ 3.0 kg ha^{-1}	189.4	23.63	177.7	23.68
T_8:RDF + Vermicompost @ 3.0 t ha^{-1}	188.5	27.37	193.6	26.73
S. Em ±	0.316	0.012	0.198	0.038
CD (p = 0.05%)	0.96	0.037	0.601	0.114

Note: RDF: Recommended Dose of Fertilizer; **DAS:** Days After Sowing; **FYM:** Farm Yard Manure

Economics

The calculation of economics of the soybean cultivation under different treatments was worked out to know the best treatment for recommendation of soybean cultivation under rainfed condition are presented in Table 6. The net returns were influence by application of super absorbent polymers and organic manures. The higher net return (Rs. 68255 ha^{-1}) was recorded with application of RDF + Potassium polyacrylate @ 7.5 kg ha^{-1} compared to other treatments. Treatments with application of RDF + Potassium polyacrylate @ 10.0 kg ha^{-1} and RDF + Humic acid @ 3.0 kg ha^{-1} were found next in the order (Rs. 66404 ha^{-1} and Rs. 60191ha^{-1},

respectively). Application of RDF (25:60:25 kg N, P_2O_5, K_2O ha^{-1}) recorded lower net return (Rs. 45964 ha^{-1}). Higher net returns and B: C ratio are due to higher yield and relatively lower cost of production, similar results were reported by Anon., (2014) [4] in castor and Shanwad *et al*., (2015) [18] in sunflower.

Table 4: Economics of the soybean cultivation as influenced by organic manures and super absorbent polymers

Treatment	Gross income (₹ ha^{-1})	Total cost (₹ha^{-1})	Net returns (₹ha^{-1})	B:C ratio
T_1:RDF (25-60-25 kg N, P_2O_5, K_2O ha^{-1})	70551	24587	45964	2.87
T_2:RDF + 3.0 t FYM ha^{-1}	80662	26987	53675	2.99
T_3: RDF + K polyacrylate @ 5.0 kg ha^{-1}	81894	26082	55812	3.14
T_4: RDF + K polyacrylate @ 7.5 kg ha^{-1}	94759	26505	68255	3.58
T_5: RDF + K polyacrylate @ 10.0 kg ha^{-1}	94241	27837	66404	3.39
T_6: RDF + Pusa Hydrogel @ 7.5 kg ha^{-1}	87241	38087	49154	2.29
T_7: RDF + Humic acid @ 3.0 kg ha^{-1}	84778	24977	59801	3.39
T_8: RDF + Vermicompost @ 3.0 t ha^{-1}	93074	54587	38487	1.71

Note: RDF: Recommended Dose of Fertilizer; **DAS:** Days After Sowing; **FYM:** Farm Yard Manure; **₹:** Indian Rupees

Conclusion

In dryland conditions soybean production can be enhanced with application of organic manures and super absorbent polymers. Super absorbent polymers not only retain moisture in soil but it also prevents the leaching of nutrients. Application of super absorbent polymers at 7.5 kg ha^{-1} along with RDF increased the growth, yield and uptake of nutrients as compared to other treatments. Net returns and B:C ratio was also recorded higher with above said treatment.

Acknowledgments

The author is immense pleasure to thank the Shaikh Zayed University and World Bank for providing opportunities to pursue my further studies with financial support. I would like to thanks Dr. Anayetullah Anayet and Dr. Habimana Sylvester who have, in so many ways provided help during my M.Sc. programme which is always remembered.

References

1. Akhter J, Mahmood K, Malik KA, Mardan A, Ahmad M, Iqbal MM. Effects of hydrogel amendment on water storage of sandy loam and loam soils and seedling growth of barley, wheat and chickpea. Plant soil environ. 2004; 50(10):463-469.
2. Al-Harbi AR, Al-Omran AM, Shalaby AA, Choudhary MI. Efficacy of a hydrophilic polymer declines with time in house experiments. Horti. Sci. 1999; 34:223-224.
3. Anonymous. Directorate of Economics and Statistics, Department of Agriculture and co-operation. 2016; 13:44-78.
4. Anonymous. Effect of hydrogel on yield and economics of castor – S K Nagar In: Annual Progress Report, All India Coordinated Research Project for Dryland Agriculture. Central Research Institute for Dryland Agriculture, Hyderabad, 2014, 111-112.
5. Anonymous. Enhancing water use efficiency in rainfed maize in Udaipur. In: Annual progress report, all India coordinated research project on maize, Indian institute of maize research, IARI, New Delhi, 2016, 145.
6. Anter F, De Boodt M. Preliminary results on the direct effect of conditioners on plant growth and nutrient uptake. Med. Fac. Landbouww Rijksuni Gent. 1976; 41:287-92.
7. Atiyeh O, Ebrahim GM. The effect of different levels of irrigation with super absorbent polymer (S.A.P) treatment on growth and development of myrobalan (*Prunus cerasifera*) seedling. Afric. J Agri. Res. 2013; 8(17):1813-1816.
8. Chauhan GS, Verma NS, Basin GS. Effect of extrusion processing on the nutritional quality of protein in rice legume blends. Nahrung 2005; 32:43.
9. El Hady OA, Tayel MY, Lofty AA. Super gel as a soil conditioner and its effects on plant growth, enzyme activity, water use efficiency and nutrient uptake. Acta. Horti. 1981; 19:257-265.
10. El-Salmawi KM. Application of polyvinyl alcohol (pva)/carboxymethyl cellulose (cmc) by conventional crosslinking or by freezing and thawing. J Macromol. Sci. 2007; 44:619-624.
11. Godavari S, Gaikwad Soniya C, Vilhekar PN, Mane, Vaidya ER. Impact of organic manures and hydrophilic polymer hydrogel on conservation of moisture and sunflower production under rainfed condition. Adv. J Crop Improv. 2017; 8(1):31-35.
12. Jackson ML. Soil chemical analysis, prentice hall of India, Pvt. Ltd., New Delhi, 1973.
13. Johnson MS, Veltkamp CJ. Structure and functioning of water-storing agricultural polyacrylamides. J Sci. Food. Agri. 1985; 36:789-793.
14. Mondal S, Joyaram D, Pradhan BK. Effect of fertilizer and FYM on the yield and yield components of pigeon pea. Environ. Eco. 2011; 8:233-26.
15. Rachna Rana, Dinesh Badiyala, Ramesh, Shilpa Kaushal. Effect of organic manures on sustainable agriculture and soil quality. Popular Kheti 2014; 2(2):65-70.
16. Rajpar I, Bhatti MB, Zia-Ul-Hassan, Shah AN, Tunio SD. Humic acid improves growth, yield and oil content of *Brassica compestris* L. Pak. J Agri., Engg. Vet. Sci. 2011; 27(2):125-133.
17. Rifat H, Safdar A. Water absorption by synthetic polymer (aquasorb) and its effect on soil properties and tomato yield. Int. J Agri. Biol. 2004; 6(6):999-1002.
18. Shanwad UK, Shankergoud I, Vikas Kulkarni, Govindappa MR, Ghante VN. Adaptations to climate change: use of polymer hydrogel to mitigate biotic stress in sunflower. Karnataka J Agric. Sci. 2015; 28(5):833-836.
19. Silberbush M, Adar E, De-Malach Y. Use of hydrophilic polymer to improve water storage and availability to crops grown in sand dunes (corn irrigated by trickling). Agri. Water Mgmt. 1993; 23:303-313.
20. Sivapalan S. Some benefits of treating a sandy soil with a cross-linked type polyacrylamide. Aus. J Exptl. Agri. 2006; 46:579-584.
21. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr. Sci. 1956; 25(8):259-260.

22. Wang HX, Zhang L, Dawes WR, Liu CM. Improving water use efficiency of irrigated crops in the north China plain-measurements and modeling. Agri. Water Mgmt. 2001; 48:151-167.
23. Yazdani F, Allahdadi I, Akbari GA. Impact of super absorbent polymer on yield and growth analysis of soybean (*Glycine max* L.) under drought stress condition. Pak. J Bio. Sci. 2007; 10:4190-4196.
24. Yazdani F, Dadi IA, Akbari QA, Behbahani MR. Effect of different rates of super absorbent polymer (Tarawat A200) on soybean yield and yield components (*Glycine max* L.). J Res. Devl. 2008; 75:167-174.