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Grain yield and meteorological indices of wheat as influenced by application of various organic nutrient sources under Akola condition

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Abstract
A field investigation was conducted at agronomy farm, Dr. P.D.K.V, Akola during rabi season of 2016. The soil of experimental plot was clayey in texture, medium in organic carbon, moderate in available nitrogen, medium in available phosphorus and high in potassium. The wheat crop was sown on 22nd November 2016 and harvested in 13th Mar, 2017. Overall the weather during growing season was faverable. Experiment was laid out in Randomised Block Design (RBD) with ten (10) treatments replicated thrice. The gross and net plot sizes were 5.4 m x 7.0 m and 4.68 m x 6.16 m, respectively. Treatments include control (T_1), Compost @ 8.5 t ha^{-1} (T_2), Soil application of Azotobacter and PSB @ 10.0 kg ha^{-1} (T_3), Liquid Organic NPK three foliar sprays (T_4), Liquid Organic K foliar spray (T_5), Compost + Soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK(T_6), compost + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash (T_7), Soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash (T_8), Compost + Soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash(T_9), Compost + Soil application of Azotobacter and PSB (T_{10}).
Result indicated that grain and straw yield was significantly influenced by treatments applied with compost + soil application of Azotobacter and PSB + 3 foliar sprays of liquid orgaic NPK + one foliar spray of liquid organic potash. The harvest index of wheat (42.87) was recorded higher with application compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK and one foliar spray of liquid organic potash. Growing degree days (GDD) calculated from the data revealed that significantly higher GDD were recorded by treatment with application of compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + one foliar spray of liquid organic potash. Similarly heliothermal unit found non-significant during the study. But heat unit use efficiency of grain yield and total biomass was significantly higher with application of compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash.

Keywords: organic fertilizers, Wheat Heliothermel unit, growing degree days

Introduction
Wheat (*Triticum aestivum*) is an annual plant of graminea family. It is most widely cultivated as staple food crop of the world. The outstanding and unique historical feature of wheat cultivation is the prominence of this staple food plant in humanity's progressive domination as a colonizer of Worlds land surface. It is cultivated extensively in north western and central zone. North West India along with Afghanistan probably forms the center of origin of bread wheat and India is one of the ancestral land of this essential food crop. More land is devoted worldwide to the production of wheat than any other crop. USA, Russia, China, Australia, Germany, France, Argentina and India are the main wheat producing countries required in order to survive.
The main species of wheat are Common wheat (*Triticum aestivum*.), Durum wheat (*Triticum durum*) and Emmer wheat (*Triticum dicoccum).* It is grown across the wide range of environments around the world has the highest adaptation among all the crop species. Worldwide more land is devoted to the production of wheat than any other crop. In India more than 80 percent of the total area of Wheat is under *Triticum aestivum*. Whereas, the area under (*Triticum durum)* and *Triticum dicoccum*is only 10 percent and 1 percent, respectively. In India wheat is second important food crop next to rice. It was the crop that brought in the green revolution and paved the way for the food security in India.

It contributes about 25 percent of the total food grain production of the India. Wheat is grown all over the India, from sea level up to elevation of 3568 meters in the Himalaya (Rao *et al*. 1992) [5].

Material and Methods

A field investigation was conducted at agronomy farm, Dr. P.D.K.V, Akola During *rabi* season of 2016. The soil of experimental plot was clayey in texture, medium in organic carbon, moderate in available nitrogen, medium in available phosphorus and high in potassium. The wheat crop was sown on 22ndNovember 2016 and harvested in 13th Mar, 2017. Overall the weather during growing season was good. Experiment was laid out in Randomised Block Design (RBD) with ten (10) treatments replicated thrice. The gross and net plot sizes were 5.4 m x 7.0 m and 4.68 m x 6.16 m, respectively. Treatments include control (T_1), Compost @ 8.5 t ha^{-1} (T_2), Soil application of Azotobacter and PSB @ 10.0 kg ha^{-1} (T_3), Liquid Organic NPK three foliar sprays (T_4), Liquid Organic K foliar spray (T_5), Compost + Soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK(T_6), compost + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash (T_7), Soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash (T_8), Compost + Soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash(T_9), Compost + Soil application of Azotobacter and PSB (T_{10}).

Results

Grain yield and straw yield (kg ha^{-1})

Data regarding grain yield kg ha^{-1} as influenced by various treatments are presented in Table 1. Grain and straw yield differences recorded by various organic nutrient sources were found significant.

Table 1: Grain yield and straw yield (kg ha^{-1}) of wheat as influenced by various treatments

Treatments		Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
T_1	Control	1571	2266	40.05
T_2	Compost @ 8.5 t ha^{-1}	3636	5012	41.07
T_3	Soil application of Azotobacter and PSB @ 10.0 kg ha^{-1}	1780	2573	40.28
T_4	Liquid Organic NPK 3 foliar sprays	1864	2785	40.31
T_5	Liquid Organic Potash one foliar spray	1642	2423	40.18
T_6	$T_2 + T_3 + T_4$	4129	5759	42.07
T_7	$T_2 + T_4 + T_5$	3840	5487	41.15
T_8	$T_3 + T_4 + T_5$	1995	2989	40.95
T_9	$T_2 + T_3 + T_4 + T_5$	4275	5693	42.87
T_{10}	$T_2 + T_3$	3941	5679	41.75
SE (m) ±		195	212	1.68
CD P=0.05		577	631	NS
CV (%)		11.74	9.04	7.09

Wheat grain yield (4275 kg ha^{-1}) and straw yield (5693 kg ha^{-1}) was significantly higher with application of compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + one foliar spray of liquid organic potash over most of the treatments and being at par with application of compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK, compost + soil application of Azotobacter and PSB and Compost + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash. All treatments were yielded highly significant over control. The lowest grain yield (1571 kg ha^{-1}) and straw yield (2266 kg ha^{-1}) was recorded with control. These results are in agreement with the finding of Agarwal *et al.* (2003) [1], Desai *et al.* (2000) [2], Deshmukh *et al*. (1995) [3] and Singh and Agarwal (2001) [6].

Harvest Index

Harvest index (Table 1) calculated from the available data indicated that higher values of harvest index were registered with application of compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid organic NPK + One foliar spray of liquid organic potash (42.87 %), followed by compost + soil application of Azotobacter and PSB + Three foliar spray of liquid organic NPK (42.07 %) and compost + soil application of Azotobacter and PSB (41.75).

Heliothermal unit and heat unit efficiency of grain yield and total biomass as influenced by different organic treatments

The data presented in table 4. Indicated that the highest heliothermal unit (16846) was observed with application of compost + soil application of Azotobacter and PSB + Three foliar sprays of liquid orgnic NPK + One foliar sprays of liquid organic potash but the differences were found non - significant. Where as in respect of heat unit use efficiency for grain yield and total biomass higher values of HUE of grain yield (2.31) and total biomass (5.38) was recorded with application of compost + soil application of Azotobacter and PSB + Three foliar spray of liquid organic NPK + One foliar spray of liquid organic potash, followed by application of compost + soil application of Azotobacter and PSB + Three foliar spray of liquid organic potash and compost + soil application of Azotobacter and PSB. Similar results were reported by Peram Rao 2016 [4].

Table 4: Heliothermal unit and heat unit efficiency of grain yield and total biomass as influenced by different organic treatments.

Treatments		Helio thermal unit (^{0}C day^{-1} hr^{-1})	Heat unit efficiency grain yield (kg ha^{-10}C^{-1} day^{-1})	HUE total biomass (kg ha^{-10}C^{-1} day^{-1})
T_1	Control	17557.00	0.82	2.01
T_2	Compost @ 8.5 t ha^{-1}	17081.67	1.92	4.57
T_3	Soil application of Azotobacter and PSB @ 10.0 kg ha^{-1}	17191.00	0.93	2.29
T_4	Liquid Organic NPK 3 foliar sprays	17447.67	0.98	2.45
T_5	Liquid Organic Potash one foliar spray	17557.00	0.86	2.13
T_6	$T_2 + T_3 + T_4$	17101.33	2.21	5.30
T_7	$T_2 + T_4 + T_5$	16844.67	2.05	4.98
T_8	$T_3 + T_4 + T_5$	16825.00	1.05	2.63
T_9	$T_2 + T_3 + T_4 + T_5$	16846.00	2.31	5.38
T_{10}	$T_2 + T_3$	17101.33	2.11	5.16
SE		224.96	0.10	0.1859
CD 5%		NS	0.30	0.55

Days required to complete different phenophases of *rabi* wheat as influenced by different organic treatments

Days required to complete different phenophases are summarised and presented in Table 2. Growing degree days calculated from the daily weather data recorded at PDKV Akola are presented in Table 3 and it was observed that from sowing to harvest significantly highest (1908.40) GDD was recorded by treatments with no application of compost with followed by application of liquid organic potash (1908.40) and soil application of Azotobacter and PSB (1902.87).

Table 2: Days required to complete different phenophases of *rabi* Wheat as Influenced by different Organic treatments

Treatments	Sowing to Emergence	Sowing to Crown Root Initiation	Sowing to tillering	Sowing to late jointing	Sowing to Panical Initiation	Sowing to 50% flowering	Sowing to Dough stage	Sowing to Physiological Maturity	Sowing to harvest
T_1	4.33	20.67	30.73	41.13	50.60	62.20	88.20	100.13	112.00
T_2	3.67	18.67	30.33	39.40	49.13	61.33	85.80	98.53	111.00
T_3	4.33	20.00	30.40	40.73	49.93	49.93	86.60	99.60	111.67
T_4	3.67	20.00	30.47	40.27	49.67	61.93	86.47	99.40	111.33
T_5	4.00	20.33	30.73	40.93	50.20	50.20	87.60	99.93	112.00
T_6	3.67	17.67	29.07	38.27	48.73	60.47	84.33	97.47	109.67
T_7	4.00	18.67	29.27	39.20	49.07	60.87	85.40	98.20	110.00
T_8	3.67	19.33	30.33	40.20	49.60	61.40	86.13	98.80	111.33
T_9	3.67	17.00	28.40	37.20	48.27	59.67	84.00	96.87	109.40
T_{10}	4.00	18.33	29.07	38.27	48.87	60.67	84.87	97.60	109.93
S E (m)±	0.34	0.55	0.43	0.35	0.15	0.24	0.18	0.15	0.41
C D p=0.05	1.03	1.65	1.31	1.05	0.46	0.72	0.56	0.47	1.23

Table 3: Cumulative growing degree days (^{0}C day$^{-1.}$) of *rabi* wheat as influenced by various organic treatments.

Growing Degree Days (GDD)									
Treatments	**sowing to Emergence**	**sowing to Crown Root Initiation**	**sowing to tillering**	**sowing to late jointing**	**sowing to PanicalI initiation**	**sowing to 50% flowering**	**sowing to Dough stage**	**sowing to Physiological Maturity**	**sowing to harvest**
T_1	31.10	254.70	440.70	634.83	777.20	961.57	1412.03	1649.17	1908.40
T_2	31.17	216.00	440.70	617.50	760.30	932.47	1365.50	1615.50	1890.97
T_3	31.10	241.30	440.70	631.10	771.57	943.70	1385.50	1635.50	1902.87
T_4	31.17	241.60	440.70	624.30	760.30	943.70	1379.10	1635.50	1896.50
T_5	31.00	248.00	441.20	636.50	769.83	949.70	1398.30	1642.33	1908.40
T_6	31.43	196.73	423.00	591.40	745.60	921.23	1333.20	1596.20	1865.53
T_7	31.00	216.00	423.00	610.70	760.30	921.23	1358.70	1615.50	1871.90
T_8	31.17	228.50	441.73	631.10	760.30	937.70	1372.30	1622.17	1897.33
T_9	31.17	184.00	405.20	573.40	745.60	900.00	1333.20	1590.27	1851.20
T_{10}	31.00	209.67	423.00	591.40	750.50	921.23	1345.77	1596.20	1865.53
S E (m)±	0.11	10.71	7.88	5.86	3.92	5.74	5.74	4.20	7.48
C D p=0.05	NS	31.84	23.43	17.43	11.67	17.06	16.15	12.50	22.24

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