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Response of Integrated Nutrient Management and *In-situ* Moisture Conservation Practices on growth and yield of Soybean

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Abstract: *A field experiment was carried out at Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during Kharif season of 2013. The split plot design was used which consisted of nine treatment combinations comprising of three treatments of integrated nutrient management with three treatments of moisture conservation practices replicated three times. The crop was sown by hand dibbling method with recommended spacing of 45cm × 5cm. The application of rhizobium + recommended dose of fertilizer + FYM @ 5t ha^{-1} recorded maximum growth and yield over nutrient treatment of recommended dose of fertilizer and rhizobium + FYM @ 5t ha^{-1}. The growth and yield parameters of soybean along with seed, straw and biological yields were significantly higher in soil moisture conservation practice of opening of furrow in each row followed by opening of furrow in fourth row and flat bed sowing of soybean. Opening of furrow in each row is the most suitable and adaptive measure in soybean which produced higher seed yield (kg ha^{-1}) over opening of furrow in fourth row and flat bed. The interaction effect between integrated nutrient management and* insitu *moisture conservation practices did not influenced the growth and yield of soybean.*

Keywords*: Rhizobium, FYM, soybean,* insitu *soil moisture conservation, flat bed, furrow planting in soybean*

INTRODUCTION

Soybean rank third in its importance among the conventional oilseed crops of the country followed by groundnut, rapeseed and mustard. Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh Chhattisgarh and Gujarat are the leading states of India in soybean production. In India, Soybean is grown on an area of 10.69 million ha with production of 12.67 millions tones and average productivity of 1185 kg ha^{-1} (Anonymous, 2012). Now a days, there is a vast scope for soybean production due to high nutritional quality, more production, short duration (90-110 days), tolerate long dry spell and being leguminous crop helps in improving the fertility and productivity of soil. Hence, it is known as "Gold of soil" (Saste, 2011).

Fertilizer is one of the most important input for successful crop production. A sustainable increase in production can be obtained by using fertilizers. More scientific efforts are needed to increase the productivity of soybean per unit area and per unit time with optimum fertilizer dose. Therefore it is necessary to study the behavior of soybean under various fertilizer levels (Garud, 2013). Application of organic manures alone sustain the fertility of soil but are unable to fulfill increasing demand of growing population, whereas application of mineral fertilizers alone help to get higher yields but they cannot sustain the fertility of soil on a long term basis. Also the fertilizer use efficiency is low in all mineral fertilizer and organic manures when used separately or alone. So to overcome all these constraints organic and inorganic fertilizer level combination is used in the experimental treatment with the other treatments.

Rainfed agriculture to a great extent depends on water saving technologies. Efficient rainwater management is crucial to rainfed agriculture. Its success depends on how best rainwater is conserved and utilized. In shallow alfisol crop growing period is seriously affected due to scanty and erratic distribution of rainfall. Proper mechanical and vegetative structure can help to conserve the rainwater *insitu* and provide the essential moisture for crop growth.

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Keeping this in view, an attempt was made to study the degree of different beneficial effect of integrated nutrient management and *insitu* moisture conservation practices on growth and yield of soybean.

MATERIALS AND METHODS

The field experiment was conducted during *kharif,* season of 2013 at P. G. Research Farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The topography of the experimental plot was uniform and fairly leveled. The soil of experimental plot was clayey in texture and slightly alkaline in reaction (Soil pH – 7.5). The soil of the experimental plot was low in available nitrogen (207.31 kg ha^{-1}), medium in available phosphorus (14.55 kg ha^{-1}), very high in available potassium (451.60 kg ha^{-1}) and low in organic carbon content (0.48%).

Geographically, Parbhani is situated at 409 m mean sea level altitude 19°16′ North latitude and 76°47′ East longitude and has a subtropical climate. The mean average annual precipitation is 879 mm and distributed in 57 rainy days mostly during June to September. The winter rains are low and uncertain. Most of the rainfall is received from South-West monsoon. Total amount of rainfall during crop growth period was 894.8 mm.

The experiment was laid out in split plot design which consisted of nine treatment combinations comprising of three treatments of integrated nutrient management practices with three treatments of *insitu* moisture conservation practices replicated three times. The three integrated nutrient management consisted of rhizobium + FYM @ 5t ha^{-1} (N_1), recommended dose of fertilizer (N_2) and rhizobium + recommended dose of fertilizer + FYM @ 5t ha^{-1} (N_3) as main plot treatments with three *insitu* moisture conservation practices *i.e.* flat bed (M_1), opening of furrow in each row (M_2) and opening of furrow in fourth row (M_3) as sub plot treatments were included in the investigation. Soybean variety MAUS-71 was sown by hand dibbling method at the spacing of 45 cm × 05 cm. Rhizobium seed treatment was done @ 250 g per 10 kg seed before sowing and the soybean crop was fertilized at the time of sowing with recommended dose of fertilizer (RDF) applied @ 30:60:30 NPK kg ha^{-1} by using fertilizers diammonium phosphate (DAP), urea and muriate of potash (MOP). A well decomposed farm yard manure is used as per the requirement of treatment at the rate of 5 tonnes ha^{-1}.

RESULTS AND DISCUSSION

Effect of Integrated Nutrient Management on Growth of Soybean

The growth attributing characters *viz.* height of plant (cm), number of functional leaves $plant^{-1}$, leaf area $plant^{-1}$ (cm^2), number of branches $plant^{-1}$ and total dry matter accumulation $plant^{-1}$ (g) showed higher values in the nutrient treatment where the integration of organic and inorganic fertilizers is done than those where organic and inorganic fertilizers alone are applied. Similar results were reported by Bandopadhaya *et al.* (2004), Das *et al.* (2005), Maheshbabu *et al.* (2008) and Palve and Oza (2012).

The treatment receiving rhizobium + recommended dose of fertilizer + FYM @ 5t ha^{-1} increased the more availability of nutrients to plants. Ultimately there was more uptake of nutrients in plant which in turn more synthesis of nucleic and amino acids, amides substances in growing region of meristimatic tissues, ultimately enhancing cell division and thereby increased the growth attributes.

Effect of Integrated Nutrient Management on Yield of Soybean

The yield attributing characters viz. number of pods $plant^{-1}$, number of seeds $plant^{-1}$, weight of pod $plant^{-1}$, weight of seed $plant^{-1}$ were found to be increased by the application of rhizobium + recommended dose of fertilizer + FYM @ 5t ha^{-1} than those of recommended dose of fertilizer and rhizobium + FYM @ 5t ha^{-1}.

Seed yield is a function of yield attributes. The application of rhizobium + RDF + FYM @ 5t ha^{-1} (N_3) recorded the highest seed yield than rhizobium + FYM @ 5t ha^{-1} (N_1) and recommended dose of fertilizer (N_2). The increase in seed yield might be the result of more number of pods $plant^{-1}$ which is the integrative effect of organic and inorganic fertilizers application. Similar results were reported by Joshi and Billore (2004), Konthoujam Nandini Devi *et al.* (2013) and Sikka *et al.* (2013). Similar trend was observed in case of straw and biological yields of soybean.

Effect of Moisture Conservation Practices on Growth of Soybean

Insitu moisture conservation practices influenced the growth characters significantly *viz.* plant height, number of functional leaves, no. of branches $plant^{-1}$, leaf area $plant^{-1}$ and total dry matter accumulation $plant^{-1}$.

Table 1
Growth parameters of soybean as influenced by different treatments

Treatment	*Plant Height (cm)*	*No. of Functional leaves at 90 DAS*	*No. of Branches plant^{-1}*	*Leaf area plant^{-1} at 90 DAS*	*Dry matter plant^{-1} (g)*
Integrated Nutrient Management (3)					
N_1 : Rhizobium + FYM @ 5t ha^{-1}	42.94	6.47	3.57	284.06	31.52
N_2 : Recommended dose of fertilizer	43.60	7.03	4.42	331.57	34.56
N_3 : Rhizobium + RDF + FYM @ 5t ha^{-1}	45.19	7.52	4.73	372.52	36.09
S.E$_m$ ±	0.19	0.13	0.27	9.27	0.54
C.D. at 5 %	0.58	0.41	0.84	27.22	1.50
Moisture Conservation Practices (3)					
M_1 : Flat bed	42.79	6.57	3.76	274.05	32.03
M_2 : Opening of furrow in each row	44.99	7.52	4.84	347.15	36.15
M_3 : Opening of furrow in fourth row	43.95	6.94	3.92	309.68	33.96
S.E$_m$ ±	0.08	0.11	0.19	10.73	0.63
C.D. at 5%	0.25	0.35	0.58	31.43	1.84
Interaction (N × M)					
S.E$_m$ ±	0.14	0.19	0.33	18.59	1.09
C.D. at 5%	NS	NS	NS	NS	NS
General mean	43.91	7.01	4.20	319.83	34.05

Table 2
Yield attributing characters of soybean as influenced by different treatments

Treatment	*No. of pods plant^{-1}*	*Weight of pod plant^{-1} (g)*	*No. of seeds plant^{-1}*	*Weight of seed plant^{-1} (g)*	*100 seeds weight (g)*
Integrated Nutrient Management (3)					
N_1 : Rhizobium + FYM @ 5t ha^{-1}	33.51	7.46	52.47	5.18	9.97
N_2 : Recommended dose of fertilizer	35.31	8.56	60.20	6.04	10.00
N_3 : Rhizobium + RDF + FYM @ 5t ha^{-1}	37.70	9.36	70.53	6.92	9.54
S.E$_m$ ±	0.54	0.06	1.71	0.27	0.09
C.D. at 5 %	1.60	0.20	5.25	0.82	NS
Moisture Conservation Practices (3)					
M_1 : Flat bed	33.57	7.37	51.73	5.36	10.36
M_2 : Opening of furrow in each row	38.10	9.52	66.93	6.69	10.00
M_3 : Opening of furrow in fourth row	35.50	8.44	59.25	5.92	9.99
S.E$_m$ ±	0.63	0.05	2.05	0.20	0.08
C.D. at 5%	1.85	0.15	6.01	0.60	NS
Interaction (N × M)					
S.E$_m$ ±	1.09	0.08	3.55	0.34	0.13
C.D. at 5%	NS	NS	NS	NS	NS
General mean	35.61	8.45	60.18	6.01	9.97

The moisture conservation practice i.e. opening of furrow in each row (M_2) recorded significantly maximium plant height, number of functional leaves, number of branches plant^{-1}, leaf area plant^{-1} and total dry matter accumulation plant^{-1} than those of opening of furrow in fourth row (M_3) and flat bed (M_1) sowing of soybean. Opening of furrow in each row resulted in more conservation of water as well as draining out excess water during high rainfall period of crop growth which turn into proper growth of crop. These results are in conformation with the results of Surnar (2012).

Effect of Moisture Conservation Practices on Yield of Soybean:

The yield attributing characters *viz*. number of pods plant^{-1}, number of seeds plant^{-1}, weight of pod plant^{-1}, weight of seed plant^{-1} were significantly highest in the opening of furrow in each row (M_2) followed by opening of furrow in fourth row (M_3) and flat bed (M_1) sowing of soybean. Increase in number of pods plant^{-1} due to proper growth of crop resulted in greater translocation of food material to the reproductive part, which also reflected towards superiority in yield attributing characters.

Table 3
Seed, straw and biological yields (kg ha^{-1}) and harvest index of soybean as influenced by various treatments

Treatment	*Seed yield (kg ha^{-1})*	*Straw yield (kg ha^{-1})*	*Biological yield (kg ha^{-1})*	*Harvest index (%)*
Integrated Nutrient Management (3)				
N_1 : Rhizobium + FYM @ 5t ha^{-1}	1852.53	2809.10	4661.63	39.73
N_2 : Recommended dose of fertilizer	1980.59	2920.65	4901.24	40.40
N_3 : Rhizobium + RDF + FYM @ 5t ha^{-1}	2464.26	3572.06	6036.32	40.82
S.E$_m$ ±	38.30	29.90	46.58	–
C.D. at 5%	117.86	92.02	143.58	–
Moisture Conservation Practices (3)				
M_1 : Flat bed	1907.29	2813.05	4720.34	40.30
M_2 : Opening of furrow in each row	2382.87	3385.76	5768.63	41.50
M_3 : Opening of furrow in fourth row	2007.23	2948.89	4956.12	40.40
S.E$_m$ ±	23.70	72.07	42.69	–
C.D. at 5%	72.94	221.79	131.38	–
Interaction (N × M)				
S.E$_m$ ±	41.05	124.83	73.95	–
C.D. at 5%	NS	NS	NS	–
General mean	2098.94	3100.44	5199.57	40.52

Opening of furrow for moisture conservation had profound effect on seed, straw and biological yields (kg ha^{-1}). The increase in seed yield (kg ha^{-1}) was attributed to increased growth parameters and yield attributes of soybean. This might be due to more conservation of water by opening of furrowin each row which resulted in higher values of yield attributes which turned in higher yields of soybean crop. This results correlate with the work of Gokhale *et al.* (2012) and Surnar (2012).

Interaction Effect of Integrated Nutrient Management and Moisture Conservation Practices on Soybean

The interaction effect between integrated nutrient management and *insitu* moisture conservation practices were found to be non-significant in influencing the various growth attributes, yield attributes, seed (kg ha^{-1}), straw (kg ha^{-1}) and biological yields (kg ha^{-1}) of soybean.

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