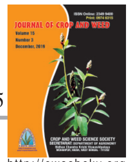
Journal of Crop and Weed, 18(2): 71-76 (2022)

ISSN- O : 2349 9400 ; P : 0974 6315



http://cwssbckv.org
www.cropandweed.com

Weed dynamics and yield of soybean as influenced by integrated nutrient and weed management practices

[*]M. APON AND D. NONGMAITHEM

Department of Agronomy, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema (797106), India

Received : 20.02.2022 ; Revised : 11.07.2022 ; Accepted : 14.07.2022

DOI: https://doi.org/10.22271/09746315.2022.v18.i2.1575

ABSTRACT

In the year 2017 and 2018, a field trial on soybean was performed in the kharif season. The application of 75% RDF + 25% organic through farmyard manure + Phosphate solubilizing bacteria treatment was found showing highest plant height (47.39), number of primary branches (25.04), plant dry matter accumulation (25.04 g plant^{-1}), seed yield (1.63 t ha^{-1}), and stover yield (2.27 t ha^{-1}). On the other hand, treatment 50% RDF+50% organic through Rhizobium + Phosphate Solubilizing Bacteria registered minimum density as well as dry weight of weeds. Regarding weed management practices, minimum weed density and dry weight; and maximum soybeans' growth and yield were registered under three hand weedings (hand weeding at 15, 30, 45 DAS).

***Keywords*:** Farmyard manure, propaquizafop, rhizobium, soybean and yield

In India, soybean is one essential rainy season crop, and the average crop productivity in North Eastern Region, mainly Arunachal Pradesh, Meghalaya and Nagaland, is high. Soybean production has vast scope due to its high quality in nutrition, more production, short crop duration of about 90-110 days, long dry spell tolerance and improving soil fertility and productivity. However, India's soybean productivity is generally lesser (0.95 t ha^{-1}) than the world average (2.3 t ha^{-1}) though it has high yielding potential (4.5 t ha^{-1}). This is due to inadequate fertilizer use, multiple-nutrient deficiencies, inadequate recycling of inorganic resources, and intense weed competition (Aziz *et al*., 2011; Nainwal *et al*., 2010; Chaturvedi *et al*., 2010). Therefore, proper nutrient management and successful weed control are crucial factors for obtaining an optimum yield. Integrated soil fertility management, which involves integrating organic and inorganic fertilizers and microbial inoculants, has become essential because in the long-term it will sustain soil productivity. It also helps in maintaining soil health and ultimately biodiversity as a whole (Bejiga, 2004; Singh and Rai, 2004; Ellafi *et al*., 2011). It has been reported by Lourduraj (2000) that applying inorganic nutrients and organic manures augmented the soybeans' growth and yield significantly which opposed to their individual application.

In the early season, soybean crop is not a strong competitor; therefore, weeds outgrow them. In the course of the initial 20 to 45 DAS (days after sowing) the crop, weed competition is regarded as most critical period. So, it is required at that time to keep weeds under control for optimum yield (Bali *et al*., 2016). Inter cultivation on time is not permitted due to continuous rainfall, and managing weeds manually is also tricky because of the shortage of labour and high labour charges during the peak time for weeding. For soybean, many labelled herbicides like pre-emergence, post-emergence and pre-plant incorporated, are available (Kells *et al*., 2004). There is a need to emphasize on judicious combinations of cultural and chemical weed control methods concerning environmental grounds. Therefore, the integrated weed management practice has become the need of the hour to control weeds as it aims to reduce the dosage of herbicides in the best way to sustain and aid in augmenting soybean production. Therefore, considering all the given points, the integrated nutrient and weed management practices' effect on dynamics of weeds including soybeans' yield, was determined by conducting two-years field experiment.

MATERIALS AND METHODS

During *kharif* seasons of the year 2017 and 2018, field trial at the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University was conducted which is situated at 25°45'43" N latitude and 95°53'04" E longitude and 310 meters above sea level. The soil pH was 4.63, 1.07% of organic carbon and sandy loam in texture. The soil available nitrogen, available phosphorus and available potassium were 328.65 kg ha^{-1}, 13.44 kg ha^{-1} and 165.87 kg ha^{-1}, respectively. Using split-plot design, treatments comprising of three different nutrient managements, *viz*., N_1-100% RDF-NPKS (20:60:40:20 Kg ha^{-1}), N_2-75% RDF + 25% organic through farmyard manure (*i.e*., at 5

Email: meshen56@gmail.com

t ha^{-1}) and Phosphate Solubilizing Bacteria (20 g kg^{-1} seed), and N_3-50% RDF + 50% organic through *Rhizobium* (20g kg^{-1} seed) and Phosphate Solubilizing Bacteria (20 g kg^{-1} seed) in main plot and five weed managements viz., W_1-weedy check, W_2-three hand weedings (15, 30 and 45 DAS), W_3-mechanical weeding (20 and 40 DAS), W_4-pendimethalin 30% EC @ 1 kg ha^{-1} (as PRE) *fb* hand weeding at 30 DAS; and W_5-propaquizafop 10% EC @ 0.075 kg ha^{-1} (as PoE) *fb* hand weeding at 45 DAS in sub-plot were tested and replicated thrice.

60 kg ha^{-1} of seed rate and JS 97-52 variety was used; and within each plot, spacing of 40 cm x 10 cm was maintained. Before planting, total dose of nutrients was incorporated into the soil as basal application. A knapsack sprayer was used for applying herbicides. Wheel hoe was used for the mechanical weeding purpose. From each plot, five healthy plants were randomly selected to observe growth parameters. The observations on yield parameters were taken at harvest. Utilizing statistical analysis through analysis of variance (Gomez and Gomez, 1984), and data of two years were pooled for study. 'F' test at 5 per cent level of probability was used inorder to test significance of different source of variation.

RESULTS AND DISCUSSION

Weed flora

During both years, thirteen (13) species of weeds were noted in the field where research was conducted *i.e.*, grasses *(Cynodon dactylon*, *Digitaria sanguinalis* and *Eleusine indica*); sedges (*Bulbostylis barbata*, *Cyperus kyllingia, Cyperus iria*,); and BLW-broad leaved weeds (*Amaranthus viridis*, *Ageratum conyzoides*, *Borreria latifolia*, *Cleome rutidosperma*, *Mimosa pudica* and *Mollugo pentaphylla*).

At 30 DAS, the relative density of grasses, sedges, BLW were 44.33%, 21.18%, 34.50%, respectively. Similarly, at 60 DAS, the relative density was 44.14% (grasses), 22.24% (sedges) and 33.62% (BLW), over the weedy check plots.

Weed density and weed dry weight

Nutrient treatment 50% RDF + 50% organic through *Rhizobium* + Phosphate solubilizing bacteria recorded lowest density as well as dry weight of grasses, sedges and broad-leaved weeds at 30 DAS and 60 DAS. Likewise, different nutrient treatments (Table 1) also influenced significantly the total weed density including its dry weight. Highest total weed count and dry weight were noted under 75% RDF + 25% through farmyard manure + Phosphate solubilizing bacteria. This might have been due to the presence of weed seeds in the farmyard manure. The addition this organic manure also made the soil condition favourable for emergence of weeds in the field. These findings correspond with that of Aggarwal and Ram (2011) and Bijarnia *et al*. (2017).

Table 1 shows that grasses, sedges, and broad-leaved weeds were significantly influenced by weed management treatments at 30 DAS and 60 DAS. Weed density and dry weight were significantly lower under all weed control treatments as compared to weedy check.

At 30 DAS, weed density as well as dry weight were found lowest under three hand weedings treatment. Subsequently, by mechanical weeding at 20 and 40 DAS; pendimethalin @ 1 kg ha^{-1} (PRE) *fb* hand weeding at 30 DAS and propaquizafop @ 0.075 kg ha^{-1} (PoE) *fb* hand weeding at 45 DAS. At 30 DAS, it was found that pendimethalin was successful in controlling sedges and broad-leaved weeds at early growth stage. This corresponded with the findings reported by Deore *et al*. (2009). In contrast, propaquizafop application as post-emergence were found effective in suppressing grasses but was unable to control broad-leaved weeds and sedges. These confirms with findings by Panda et al. (2015) including Singh *et al*. (2019).

Three hand weedings treatment recorded lowest total weed density and dry weight at 60 DAS, followed by propaquizafop @ 0.075 kg ha^{-1} *fb* hand weeding at 45 DAS; and pendimethalin @ 1 kg ha^{-1} *fb* hand weeding at 30 DAS. It shows that supplementing either pre-emergence herbicides or post-emergence herbicides with hand weeding reduced weed density and dry weight effectively (Deore *et al*., 2009). Three hand weedings treatment successfully removed all types of weeds.

Weed control efficiency (WCE)

Nutrient management treatments- 75% RDF + 25% organic through farmyard manure + Phosphate solubilizing bacteria (N_2); and 50% RDF + 50% organic through *Rhizobium* + Phosphate solubilizing bacteria (N_3), recorded highest WCE at 30 and 60 DAS, respectively. It is attributable to lesser dry weight of weed. At 30 DAS, three hand weedings gave the maximum WCE, followed by mechanical weeding treatment. Likewise, at 60 DAS, maximum WCE was shown by three hand weedings. It was followed by propaquizafop @ 0.075 kg ha^{-1} *fb* hand weeding at 45 DAS; and pendimethalin @ 1 kg ha^{-1} *fb* hand weeding at 30 DAS.

Growth parameters

At harvest, the treatment 75% RDF + 25% organic through farmyard manure + Phosphate solubilizing bacteria registered tallest plant height and maximum dry matter accumulation (Table 3). It performed at par with 50% RDF + 50% organic through *Rhizobium* + Phosphate solubilizing bacteria. The lowest plant height

Table 1: Influence of integrated nutrient and weed management practices on weed density (no m^{-2}) at 30 DAS and 60 DAS (Pooled data)

Treatment	Density of weeds (no m^{-2}) at 30 DAS			Total density of weeds at 30 DAS	Density of weeds (no m^{-2}) at 60 DAS			Total density of weeds at 60 DAS
	Grasses	Sedges	Broad-leaved weeds		Grasses	Sedges	Broad-leaved weeds	
Nutrient management								
N_1	7.68 (64.27)	5.63 (34.83)	6.32 (44.47)	11.57 (143.57)	5.66 (43.60)	3.59 (20.87)	5.03 (33.93)	8.37 (98.40)
N_2	7.83 (66.67)	5.86 (37.23)	6.78 (50.77)	12.06 (154.77)	5.85 (46.73)	3.73 (22.77)	5.29 (37.40)	8.73 (106.90)
N_3	7.30 (58.47)	5.28 (30.67)	6.00 (40.27)	10,57 (129.40)	5.44 (40.97)	3.36 (18.23)	4.76 (30.70)	7.96 (89.90)
SEm(±)	**0.161**	**0.085**	**0.070**	**0.122**	**0.029**	**0.083**	**0.070**	**0.069**
LSD(0.05)	**NS**	**0.335**	**0.274**	**0.479**	**0.133**	**NS**	**0.274**	**0.271**
Weed management								
W_1	10.31 (106.33)	7.14 (50.78)	9.07 (82.06)	15.46 (239.17)	11.95 (142.44)	8.50 (72.11)	10.43 (108.50)	17.97 (323.06)
W_2	4.39 (18.94)	2.55 (6.11)	3.82 (14.44)	6.31 (39.50)	2.27 (4.83)	0.74 (0.06)	2.26 (4.78)	1.41 (9.67)
W_3	6.84 (47.56)	4.53 (20.50)	6.04 (37.00)	10.24 (105.06)	6.44 (41.56)	4.91 (24.22)	6.00 (36.06)	10.09 (101.83)
W_4	10.00 (100.22)	6.99 (48.61)	4.26 (17.83)	12.91 (166.67)	4.63 (21.22)	2.44 (5.61)	3.81 (14.11)	3.60 (40.83)
W_5	6.48 (42.61)	6.75 (45.39)	8.63 (74.50)	12.75 (162.50)	2.96 (8.89)	1.22 (1.11)	2.62 (6.61)	1.77 (16.61)
SEm(±)	**0.152**	**0.099**	**0.128**	**0.116**	**0.104**	**0.102**	**0.097**	**0.099**
LSD(0.05)	**0.442**	**0.288**	**0.37**	**0.337**	**0.303**	**0.296**	**0.282**	**0.290**

Note: The figures within parentheses indicate original value and data were subjected to the square root transformation $\left(\sqrt{x+0.5}\right)$.

was recorded in 100% RDF, where no organic manure or biofertilizers were applied. The influence of integrated nutrient management was evident with crop growth development. The continual availability of nutrients to the crop due to slow nutrient release from farmyard manure throughout the crop growing period may be the reason for the special effect on plant height (Raj *et al.*, 2019). More dry matter production at higher fertility may lead to vigorous growth and higher LAI (Bijarnia *et al.*, 2017). Highest primary branches plant^{-1} (4.32) was registered in 75% RDF + 25% organic through farmyard manure + Phosphate solubilizing bacteria. Primary branches plant^{-1} at 50% RDF + 50% organic through *Rhizobium* + Phosphate solubilizing bacteria and 100% RDF was statistically at par.

It was found that three hand weedings treatment registered tallest plant height significantly, which was also at par with propaquizafop @ 0.075 kg ha^{-1} fb hand weeding at 45 DAS. Then, pendimethalin @ 1 kg ha^{-1} *fb* hand weeding at 30 DAS and mechanical weeding at 20 DAS and 40 DAS followed thereafter. Amongst all weed management treatments, the weedy plot recorded lowest plant height. Three hand weedings treatment also significantly registered maximum primary branches and dry matter accumulation plant^{-1}.

Yield

The varied nutrient management influenced seed yield significantly (Table 3). Seed yield was noted highest under 75% RDF + 25% through FYM + PSB. Treatments 50% RDF + 50% organic through *Rhizobium* + PSB (N_3) and 100% RDF (N_1) followed next. Stover yield was higher under 75% RDF + 25% organic through farmyard manure + Phosphate solubilizing bacteria (N_2), which was at par with 50% RDF + 50% organic through *Rhizobium* + Phosphate solubilizing bacteria. The total

Table 2: Influence of integrated nutrient and weed management practices on dry weight of weeds (g m^{-2}) at 30 and 60 DAS (Pooled data)

Treatment	Dry weight of weeds (no m^{-2}) at 30 DAS			Total dry weight of weeds at 30 DAS	Dry weight of weeds (no m^{-2}) at 60 DAS			Total dry weight of weeds at 60 DAS
	Grasses	Sedges	Broad-leaved weeds		Grasses	Sedges	Broad-leaved weeds	
Nutrient management								
N_1	3.42 (14.13)	2.89 (9.08)	2.99 (10.28)	5.43 (33.49)	5.38 (45.51)	3.52 (20.26)	3.46 (22.03)	7.27 (87.79)
N_2	3.54 (14.76)	2.94 (9.35)	3.20 (11.73)	5.63 (35.85)	5.61 (49.93)	3.64 (21.99)	3.66 (24.52)	7.59 (96.44)
N_3	3.27 (12.91)	2.78 (8.39)	2.88 (9.64)	5.22 (30.94)	5.11 (41.95)	3.29 (17.62)	3.34 (20.56)	6.87 (80.12)
SEm(±)	**0.086**	**0.039**	**0.013**	**0.068**	**0.057**	**0.089**	**0.057**	**0.083**
LSD(0.05)	**NS**	**NS**	**0.053**	**0.268**	**0.224**	**NS**	**0.223**	**0.326**
Weed management								
W_1	5.17 (26.41)	3.76 (13.69)	4.60 (20.73)	7.82 (60.83)	13.07 (170.57)	8.56 (73.21)	9.40 (87.98)	18.21 (331.77)
W_2	1.25 (1.06)	0.97 (0.45)	1.14 (0.82)	1.68 (2.32)	1.71 (2.88)	0.74 (0.07)	0.95 (0.42)	1.87 (3.37)
W_3	3.38 (11.24)	2.41 (5.38)	2.95 (8.51)	5.04 (25.12)	5.80 (34.01)	4.43 (19.80)	4.56 (21.16)	8.64 (74.97)
W_4	4.92 (23.82)	3.65 (12.86)	2.02 (3.64)	6.38 (40.32)	4.15 (17.20)	2.38 (5.29)	1.33 (1.29)	4.88 (23.78)
W_5	2.33 (7.13)	3.57 (12.32)	4.40 (19.08)	6.22 (38.53)	2.08 (4.31)	1.31 (1.39)	1.20 (0.99)	2.61 (6.68)
SEm(±)	**0.065**	**0.057**	**0.087**	**0.077**	**0.150**	**0.102**	**0.087**	**0.151**
LSD(0.05)	**0.189**	**0.165**	**0.255**	**0.225**	**0.436**	**0.298**	**0.253**	**0.442**

Table 3: Influence of integrated nutrient and weed management practices on WCE, growth and yield of soybean (pooled data)

Treatment	WCE (%) at 30 DAS	WCE (%) at 60 DAS	Plant height (cm) at harvest	Number of primary branches plant^{-1} at harvest	Plant dry matter accumulation (g plant^{-1}) at harvest	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
Nutrient management							
N_1	45.14	73.39	39.02	3.59	20.14	1.39	2.02
N_2	45.57	73.36	47.39	4.32	25.04	1.63	2.27
N_3	44.04	73.67	43.02	3.73	23.45	1.51	2.17
SEm(±)	**-**	**-**	**1.204**	**0.092**	**0.580**	**0.021**	**0.028**
LSD (0.05)	**-**	**-**	**4.727**	**0.362**	**2.276**	**0.082**	**0.109**
Weed management							
W_1	-	-	32.13	2.99	10.80	0.66	1.34
W_2	96.19	99.00	52.41	4.78	30.91	2.07	2.63
W_3	58.42	77.46	38.84	3.53	17.66	1.09	1.93
W_4	33.37	92.91	43.68	3.88	26.35	1.78	2.39
W_5	36.63	98.00	48.66	4.23	28.66	1.94	2.49
SEm(±)	**-**	**-**	**1.016**	**0.114**	**0.657**	**0.027**	**0.036**
LSD (0.05)	**-**	**-**	**2.966**	**0.329**	**1.916**	**0.080**	**0.104**

dry matter accumulation and other plant morphological parameters of growth, *i.e*., plant height as well as the number of branches is possibly the reason for the increased seed and yield in integrated nutrient management treatment. These findings confirm with Tripathi *et al*. (2010) and Kumar *et al*. (2002). Contrary to the sole application of nutrients, applying a combination of farmyard manure and chemical fertilizers ultimately increases seed and stover yield due to the fact that nutrient availability increases and thereby, sustains it in the long run (Raj *et al*., 2019).

100% RDF treatment recorded the least seed yield. It may be the result of lesser nutrient available to the crop, mainly nitrogen during later phase of crop growth. As root nodules start to degenerate besides pod development takes place, supply of nitrogen falls short. It conforms with Raj *et al*. (2019).

Three hand weedings treatment gave significantly maximum seed yield and also stover yield. This was followed next by propaquizafop @ 0.075 kg ha^{-1} *fb* hand weeding at 45 DAS; and pendimethalin @ 1 kg ha^{-1} *fb* hand weeding at 30 DAS. Competition of weeds in inter and intra row spaces was removed entirely. Therefore, relatively greater yield attributes and the highest seed yield were attained. These results also conform with Parmar *et al*. (2017) and Kumar *et al*. (2018). Yield of seed as well as stover were least under weedy check for the reason that severe competition stress occurs and consequently, crop showed poor growth parameters and yield attributes.

From the field investigation, it can be concluded that biofertilizers integrated with chemical fertilizer and farmyard manure can obtain better growth and higher yield of soybean, and three hand weedings treatment performed best over remaining weed management treatments. Controlling weeds was also effective under treatments- propaquizafop @ 0.075 kg ha^{-1} *fb* hand weeding at 45 DAS; and pendimethalin @ 1 kg ha^{-1} *fb* hand weeding at 30 DAS.

REFERENCES

Aggarwal, N. and Ram, H. 2011. Effect of nutrients and weed management on productivity of lentil (*Lens culinaris* L.) *J. Crop Weed,* **7**(2):191-194.

Aziz, M.A., Ali, T., Bhat, M.A., Aezum, A.T. and Mahdi, S.S. 2011. Effect of integrated nutrient management on lysine and linoleic acid content of soybean (*Glycine max* (L.) Merrill) under temperate conditions. *Univers. J. Environ. Res.Technol.,* **1**(3): 385-389.

Bali, A., Bazaya, B.R., Chand, L. and Swami, S. 2016. Weed management in soybean (*Glycine max* L.). *Bioscan.* **11**(1): 255-257.

Bejiga, G. 2004. Current status of food legume production and use of biological nitrogen fixation in Ethiopia. In: *Symbiotic Nitrogen Fixation Prospects for Enhanced Application in Tropical Agriculture* (Ed. R. Serraj), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India, pp. 263-265.

Bijarnia, A.L., Yadav, R.S., Rathore, P.S., Singh, S.P., Saharan, B. and Choudhary, R. 2017. Effect of integrated nutrient and weed management measures on growth and yield attributes of mustard (*Brassica juncea* L.). *J. Pharmacogn. Phytochem.,* **6**(4): 483-488.

Chaturvedi, S., Chandel, A.S., Dhyani, A.S. and Singh, A.P. 2010. Productivity, profitability and quality of soybean (*Glycine max*) and residual soil fertility as influenced by integrated nutrient management. *Indian J. Agron.,* **55**(2): 133-137.

Deore, P.S., Khanpara, V.D., Wadile, S.C., Sonawane, D.A. and Chotodkar, S.S. 2009. Efficacy of post-emergence herbicides in soybean under various fertility levels and their residual effects on succeeding crops. *Indian J. Weed Sci*., **41**(3&4): 213-217.

Ellafi, A.M., Gadalla, A. and Galal, Y.G.M. 2011. Biofertilisers in action: Contributions on BNF in sustainable agricultural ecosystems. *Int. Sci. Res. J.,* **3**(2): 108-116.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research. A Wiley-Interscience Publication, John Wiley and Sons, New York, USA, pp. 680.

Kells, J. J., Dalley, C.D. and Renner, K.A. 2004. Effect of glyphosate application timing and row spacing on weed growth in corn (*Zea mays*) and soybean (*Glycine max*). *Weed Technol.* **18**: 177-182.

Kumar, R.P., Singh, O.N., Singh, Y., Dwivedi, S. and Singh, J.P. 2009. Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of French bean (*Phaseolus vulgaris*). *Indian J. Agric. Sci*., **79**(2): 122-128.

Kumar, S., Rana, M.C. and Rana, S.S., 2018. Effect of propaquizafop alone and in mixture with other herbicides on weed dry weight and growth and yield of soybean. *J. Crop Weed,* **14**(2): 149-153.

Lourduraj, C.A. 2000. Effect of irrigation and manure application on growth and yield of groundnut. *Acta Agron. Hung.* **48**: 83-88.

Nainwal, R.C., Saxana, S.C. and Singh, V.P. 2010. Effect of pre- and post- emergence herbicides on weed infestation and productivity of soybean. *Indian J. Weed Sci.,* **42**(1&2): 17-20.

Panda, S., Lal, S., Kewat, M.L., Sharma, J.K. and Saini, M.K. 2015. Weed control in soybean with propaquizafop alone and in mixture with imazethapyr. *Indian J. Weed Sci.,* **47**(1):31-33.

Parmar, P.S., Vishwakrma, A.K., Sharma, K.C. and Baghel, M. 2017. Study on effect of different herbicides on weed intensity and dry weight under rain-fed condition of Central in Soybean [*Glycine max* (L.) Merrill]. *J. Pharmacogn. Phytochem.,***SP1**: 102-110.

Raj, R.K., Sinha, K.K., Pandey, I.B., Choubey, A. K. and Pandit, A. 2019. Effect of nutrient and weed management on growth and yield of Soybean [*Glycine max* (L.) Merrill] in Alluvial Soil of Bihar, India. *Int. J. Curr. Microbiol. Appl. Sci.,* **8**(07): 2214-2220.

Singh, G., Virk, H.K. and Khanna, V. 2019. Pre- and post-emergence on growth, nodulation and productivity of greengram. *Indian J. Weed Sci.,* **51**(3):257-261.

Singh, R. and Rai, R. K., 2004. Yield attributes, yield and quality of soybean (*Glycine max*) as influenced by integrated nutrient management. *Indian J. Agron.,* **49**(4): 271-274.

Tripathi, M.K, Chaturvedi, S., Shukla, D.K. and Mahapata, B.S. 2010. Yield performance and quality in Indian mustard (*Brassica juncea*) as affected by integrated nutrient management. *Indian J. Agron.,* **55**(2): 138-142.