International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print)
Vol. 2, No. 6, p. 10-14, 2012
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Fresh leaf yield and flowering responses of *Brassica juncea* varieties to varying nitrogen levels

Madhara Temba Mabarani[1], James Chitamba[1*], Tavagwisa Muziri[2]

[1]*Department of Agronomy, Midlands State University, P. Bag 9055, Gweru, Zimbabwe*

[2]*Department of Horticulture, Midlands State University, P. Bag 9055, Gweru, Zimbabwe*

Received: 17 June 2012
Revised: 25 June 2012
Accepted: 26 June 2012

Key words: *Brassica juncea*, variety, nitrogen level, fresh leaf yield, flowering.

Abstract

An experiment was undertaken to evaluate fresh leaf yield and flowering responses of two *Brassica juncea* varieties (Paida and ZGS) to varying rates of nitrogen fertilizer ammonium nitrate (0; 100; 200 and 300 kg ha^{-1}) during winter of 2007 under irrigation. The experiment was arranged as a 2×4 factorial treatment structure, laid in a randomized complete block design (RCBD) with three replications. Fresh leaf yield and days to 50% flowering were measured during the course of the experiment. There was significant difference ($p<0.001$) in fresh leaf yield of the varieties. Fresh leaf yield was significantly increased to 37.3 t ha^{-1} when 300 kg ha^{-1} of NH_4NO_3 was applied as compared to control plots (0 kg ha^{-1}) which gave a yield of 32 t ha^{-1}. There was no significant difference ($p>0.05$) in days to 50% flowering due to different N treatments. There was significant difference ($p<0.05$) in days to 50% flowering of the two varieties, with Paida flowering 24 days later than the ZGS mustard. N level had significant effect only on fresh leaf yield whilst variety had significant effect on both fresh leaf yield and days to 50% flowering. The N rate of 300 kg NH_4NO_3 ha^{-1} was considered as the optimal dosage and Paida the best variety.

*Corresponding Author: James Chitamba ✉ chitambajc@gmail.com

Introduction

Brown mustard (*Brassica juncea*) is a variable species cultivated for centuries as a vegetable and oil crop, and is also a widespread weed. It is known by diverse common names, which include Indian mustard, leaf mustard and brown mustard among many others (Grubben and Denton, 2004). In Zimbabwe, the crop is one of the main cultivated leafy vegetable species which include pumpkin leaves, cowpea leaves, okra and 'chemebere dzagumana' (*Brassica carinata*) (Chigumira, 1996). Brown mustard is grown as a leafy vegetable in West and Southern Africa, known as 'laulau' in Nigeria, 'mpiru' in Malawi, and 'tsunga' in Zimbabwe (Schippers and Mnzava, 2007). The crop is important as a source of mustard in Europe, as a vegetable in Africa, and has a variety of medicinal uses; in Tanzania, the crop's roots have been given to dairy cows to promote milk production (Grubben and Denton, 2004). The crop performs better during the winter season in Zimbabwe.

A common problem in mustard production is its early flowering habit; under warm conditions, including the rainy season, flowering is much earlier than in winter resulting in depressed yields (Fusire, 2008). Schippers and Mnzava (2007) stated that under tropical African conditions, flowering occurs early as low temperatures are not required for flower induction, while water stress and low soil fertility promote early flowering. Gardner *et al.* (1985) reported that flowering is photoperiod induced but other factors may also play a role to enhance flowering, while Grubben and Denton (2004) stated that flowering factors in brown mustard include mineral nutrition, high temperature and moisture stress. Mineral nutrition, especially the supply of N, is a major limiting factor to successful mustard production as it promotes vigorous plant growth and increases leaf area which impact on yield if sustained throughout the growing season (Anonymous, 2007). Mustard is reported to respond strongly to the addition of N with yield gain of 30% or more being common (Squire, 1990). It is against this background that there is need for evaluating different N levels and mustard varieties on flowering and yield of the crop.

General recommendations for specific nutrients may vary under different climatic and soil conditions thus it is not always advisable to rely on data obtained in a different set of conditions from local conditions (Yawalkar *et al.*, 1962). In Zimbabwe, there are no reliable statistics regarding the production of brown mustard but yields often range from 8 to 35 t ha^{-1} (Grubben and Denton, 2004).

Fertilizer plays an important role in plant growth and show significant increase in yield (Khan *et al.*, 2000). There are no uniform recommendations by the Agronomists regarding N fertilizer levels for a given unit area Roy *et al.* (1981) and Khan *et al.* (1987) recommended 100-2 kg N-P ha^{-1} while Imtiaz *et al.* (1992) and Musa *et al.* (1994) reported 100-75 N-P kg ha^{-1} for best yield of the crop in Pakistan; and Fusire (2008) recommended 100 kg ha^{-1}. Therefore, there is paucity of information on the fertilizer rates relating to the cited yields in the country. Thus, although the yields cited in literature may be inviting, farmers need more illumination on fertilizer rates. Most farmers in Zimbabwe grow mustard without fertilization while still others argue that brown mustard does not require any fertilization. Thus, although information on N increasing yield of brown mustard has been documented in some places; no reliable statistics are present in Zimbabwe (Grubben and Denton, 2004) and hence there is need to study the potential of N increasing yield under Zimbabwean conditions. The present study was undertaken with the main objective of determining the response of mustard varieties to different N rates with respect to fresh leaf yield and days to 50% flowering.

Materials and methods

The field experiment was carried out during the winter of 2007 under irrigation at Agricultural Research Trust (ART) farm in Harare, Zimbabwe. The farm is located 18 km due north of Harare at an altitude of 1500 m above sea level. The area falls under Natural Region II of Zimbabwe's Agro-ecological Zones, with an average annual precipitation of about 850 mm. A 2×4 factorial treatment structure laid out in a randomized complete block design (RCBD) with three replications was used. Variety factor had two levels (Paida and ZGS) whilst N rate factor had four levels (0; 100; 200 and 300 kg ha^{-1}). Ammonium nitrate (NH_4NO_3) fertilizer was used as the N source for topdressing.

The land was thoroughly dug using a pick. Twenty four (24) plots measuring 2×1 m were then prepared and organic waste (pig waste) was applied at a rate of 30 t ha^{-1} during land preparation and it was thoroughly mixed with the soil before planting stations were marked by a dibber. The two varieties were sown on the same day in trays and transplanting was done 4 weeks after sowing, at a spacing of 60×20 cm and each plot comprised of 20 planting stations. A 1 m pathway was allowed between plots and a boarder was also made to counteract the effect of the edge. Cutworm control was done through drenching Lambda cyhalothrin (Karate) at a rate of 50 ml 100 $litres^{-1}$ water soon after transplanting. The plots were weeded periodically to control weeds and irrigated twice a week to maintain adequate moisture. Malathion 50 EC was used against aphids at a rate of 250 ml 100 $litres^{-1}$ water and topdressing with fertilizer NH_4NO_3 fertilizer (34.5%N) was done 10 days after transplanting using graduated fertilizer cups.

The first harvesting of fresh leaves was done 4 weeks after transplanting. All the harvested leaves from the same plot were tied together with a piece of cotton string bearing a tag with the plot number. Harvesting was done early morning once every week following the first harvest and the leaves were quickly taken to the shade and promptly weighed by means of a digital scale in grams. Harvesting was done until 50% of the plants had developed inflorescence since it is not economically viable to continue production beyond this point (Grubben and Denton, 2004). The total yield obtained therefore was from the first harvest up to the time 50% of the plants had flowered.

The data collected on fresh leaf yield and number of days to 50% flowering data was subjected to Analysis of Variance using GenSat Discovery Edition 3 package and their means were separated by Least Significance Difference (l.s.d.).

Results and discussion

Fresh leaf yield

There was no significant interaction ($p>0.05$) on mustard fresh leaf yield between variety and nitrogen level. There was, however, highly significant difference ($p<0.001$) on mustard fresh leaf yield due to variety, with Paida having a significantly highest yield of 37.1 t ha^{-1} as compared to ZGS which had 29.2 t ha^{-1} (Table 1). Both varieties had sufficient vegetative growth; however, flowering occurred earlier in ZGS mustard than in Paida. This can be attributed to the fact that for economic viability, harvesting is terminated when plants begin to develop inflorescence (Grubben and Denton, 2004). There were two more pickings in Paida after ZGS had attained 50% flowering leading to the higher yield. Results therefore indicate that Paida would yield more as it persisted longer than ZGS and continued to produce leaves for a much longer time.

Table 1. Effect of variety on fresh leaf yield of brown mustard.

Variety	Yield (kg $plot^{-1}$)	Yield (t ha^{-1})
Paida	7.41^a	37.1
ZGS	5.83^b	29.2
Grand mean	6.62	
Fprob	<0.001	
l.s.d	0.628	
CV%	10.8	

Means followed by the same letter are not significantly different at $p = 0.05$.

There was also a significant difference ($p<0.05$) on mustard fresh leaf yield due to different nitrogen levels, with the rate of 300 kg ha^{-1} having the highest yield (37.2 t ha^{-1}) while the other three levels had statistically similar lower fresh leaf yields (Table 2). The highest yield was obtained when N was applied at 300 kg ha^{-1}. The higher yield of brown mustard in response to top dressed N concurs with the findings of Grubben and Denton (2004); Bose *et al.* (2001) and Anonymous (2007). This can be attributed to the fact that N may increase yield by increasing leaf extension and expansion (Squire, 1990). However, it may not be easy to explain why there was no significant difference in mean leaf yield for the 0, 100 and 200 kg ha^{-1} N levels. This inconsistency compares favourably with academic research in the same area. The systematic responses of leaf area to nutrients are not well understood; adding nutrients to the soil usually increases the size of the canopy and affects senescence though inconsistently (Squire, 1990). It has also been noted that the duration of leaf extension is little affected by nutrients and is sometimes greater when nutrients are scarce than when they are plentiful (Squire, 1990).

Table 2. Effect of N level on fresh leaf yield of brown mustard.

N level (kg ha^{-1})	Yield (kg $plot^{-1}$)	Yield (t ha^{-1})
200	6.26^{a}	31.3
100	6.38^{a}	31.9
0	6.40^{a}	32.0
300	7.45^{b}	37.2
Grand mean	6.62	
Fprob	<0.05	
l.s.d	0.889	
CV%	10.8	

Means followed by the same letter are not significantly different at p = 0.05.

Days to 50% flowering

There was no significant interaction ($p>0.05$) in days to 50% flowering between variety and N level. There was also no significant difference ($p>0.05$) in days to 50% flowering due to fertilizer. This is also consistent with the findings of Gardner and Loomis (1953); Vergara and Chang (1985), as cited by Gardner *et al.* (1985). Moreover, flowering is photoperiod-induced (Gardner and Loomis, 1953). However, Gosnell (1973) reported that reduced N level as well as N deficiency favours flowering in sugar cane.

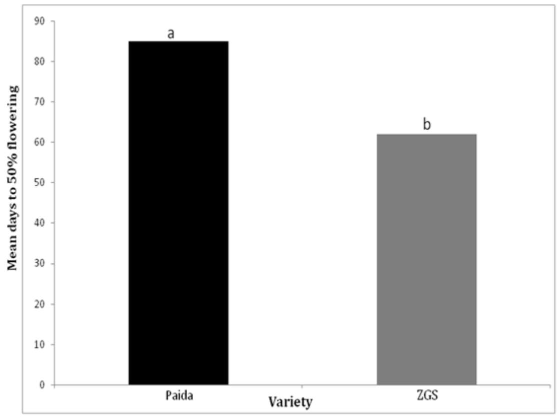

Fig. 1. Effect of variety on days to 50% flowering.

However, there was significant difference ($p<0.05$) in days to 50% flowering due to mustard variety, with Paida taking longer to flower compared to ZGS (Fig. 1). These results are consistent with those by Gosnell (1973) where tremendous differences in flowering behaviour were apparent between varieties; with NCo 310 having been the most prolific flowerer. This can also be attributed to genotypic differences between the two varieties.

Conclusion

The success of growing brown mustard largely depends upon wise selection of variety as well as following a proper fertilization programme. Basing on the research findings, 300 kg ha^{-1} of the N source NH_4NO_3 promotes optimum yield of mustard in Zimbabwe. Where fertilizer input resources are limiting, mustard growers may grow brown mustard reasonably well without any top dressing following the basal recommendation. Paida proved to be the best Zimbabwean mustard variety which gives high yield. N level does not affect flowering of mustard whist variety affects flowering.

Acknowledgements

The authors are grateful to the management and staff of Agricultural Research Trust Farm (ART Farm) for provision of expertise and adequate materials/resources for the experiment to be successfully carried out.

References

Bose TK, Kabir J, Das P, Joy PP. 2001. Tropical Horticulture Volume 2. Calcutta, India: Naya Prokash.

Chigumira F. 1996. Conservation and use of traditional vegetables in Zimbabwe. Marondera, Zimbabwe: Horticulture Research Centre.

Fusire F. 2008. Seed production manual for Indigenous Vegetables: A Guide for Small Scale Farmers. Harare, Zimbabwe: Community Technology Development Trust, 10-11.

Gardner FP, Pearce RB, Mitchell RL. 1985. Physiology of Crop Plants. Iowa, USA: Iowa State University Press.

Gosnell JM. 1973. Some factors affecting flowering in sugarcane. Proceedings of the South African Sugar Technologists' Association – June 1973.

Grubben JH, Denton OA. 2004. Plant Resources of Tropical Africa 2 – Vegetables Wageningen, Netherlands: PROTA Foundation.

Imtiaz M, Raiz H, Anwar KH, Gulzar A, Ghulam CA. 1992. Response of *Brassica* cultivars to fertilizer level under rain-fed condition. Pakistan Journal of Soil Science, **11,** 60-63.

Khan AR, Munir M, Yousaf MA. 1987. Rape seed and Mustard in Pakistan. Islamabad, Pakistan: Directorate of Publication Pakistan, Agricultural Research Council, 1-6 and 93.

Khan H, Khan MA, Hussain I, Malik AA, Baloch MS. 2000. Effect of nitrogen and phosphorus on growth and yield of *Brassica juncea*. Pakistan Journal of Biological Sciences **3(8),** 1231-1233.

Musa M, Aadal NK, Shazad MA, Chaudhry GA, Khalid AH. 1994. Yield potential and co-relation studies of mustard as effected by varying fertilizer doses and row spacing. Pakistan Journal of Soil Science **11,** 91-94.

Roy V, Maity S, Chatter BN. 1981. Growth analysis and fertilizer response of 'varuna' Indian mustard. Indian Journal of Agricultural Science **51,** 173-180.

Schippers RR, Mnzava NA. 2007. *Brassica juncea* (L.) Czern. In: van der Vossen H.A.M., Mkamilo G.S. (Eds). PROTA 14: Vegetable oils. Wageningen, Netherlands: PROTA.

Squire GR. 1990. The Physiology of Tropical Crop Production. Wallingford, UK: CAB International.

Yawalkar KS, Agarwal JP, Bokde S. 1962. Manures and Fertilizers (9th Edition). Nagpur, India: Horticultural Publishing House.