




Evaluation of radish (*Raphanus sativus* L.) varieties under net house for off season



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Article Info

ABSTRACT

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Eight varieties of radish (*Raphanus sativus* L.) were evaluated at the horticultural research farm of Agriculture and Forestry University, Chitwan, Nepal (186 masl) during the spring (February to April 2018) under the net house to identify the suitable variety for off-season radish production. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Radish varieties, Vedetar Local, Miyasinge, Tokinasi, Pusa Chetki, Mino Early Long White F1, Ivory White F1, MAHY 22 F1 and All Season were seeded in the third week of February. The highest number of leaves per plant (20.54) in MAHY 22 F1, highest plant height (43.69 cm) in Tokinasi, highest leaf area (1357.24 cm²) and the highest fresh leaf weight per plant (165.40g) was recorded in Miyasinge. With respect to yield parameters, the highest root length (19.51 cm) was recorded in Ivory White F1 followed by Mino Early Long White F1 (18.86 cm). Significantly highest root diameter (2.90 cm) was recorded in All-Season and fresh root weight (92.60 g) was recorded in Ivory White F1. Maximum biomass yield (73.22 t ha⁻¹) was recorded in Miyasinge whereas the significantly highest root yield (30.87 t ha⁻¹) was recorded in Ivory White F1. Minimum biomass yield (29.77 t ha⁻¹) and root yield (11.93 t ha⁻¹) were recorded in Pusa Chetki. Among the tested varieties, Pusa Chetki was the earliest (55 DAS) to attain the edible root size. The variety Ivory White F1 showed significantly superior growth, yield, and quality attributes.

INTRODUCTION

Radish (*Raphanus sativus* L.) is one of the most important edible, nutritious and short duration root vegetable crops grown in tropical to temperate region of the world. It is an herbaceous annual or biennial plant which belongs to the family Brassicaceae and originated in Europe and Asia (Thompson and Kelly 1957). It is one of the most frequently consumed root vegetable in different parts of the world because of its nutritious root and leaves (Jilani et al. 2010).

It is a popular due to easy to cultivate, wider range of climatic adaptation and useful for various purposes (Shrestha and Shakya 2004). Radish is sensitive to temperature requirement and its ideal

growing time may vary which depends upon the environment of the growing area and selection of the variety; farmers often manipulate sowing times for better growth and yields (Alam et al. 2010). Planting season also influence the vegetative and reproductive growth period, which affects the economic yield, rising in temperature favor the early bolting (Ebrahimi et al. 2013; Sandler 2015). The amount of light availability and the season of growing may also impact radish production (Pell et al. 1993). The Asian cultivars have high temperature adaptation and resist more heat than the European cultivars (Tang et al. 2019). High temperatures lead to decreases in water use efficiency and net photosynthetic rate, which ultimately leads to decrease the quality and yield of a crop (Oh et al. 2014). Radish splitting can occur during growth due to high temperature and moisture (Lockley et al. 2020). Light intensity plays crucial role in the growth and development of storage roots in root vegetables (Cope et al. 2014). Radish grows well in full sunshine as well as in the

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shade for good root growth; optimum temperature is 10-25°C (Pandey et al. 2017).

In Terai of Nepal radish is grown extensively as a winter season root vegetable crop (NARC 2017). In Nepal, area under radish production is about 18,250 hectares and total production is 287,200 metric ton with average production of 15.74 metric ton per hectares. In Chitwan district, radish is cultivated in an area of 190 hectares with total production of 2985 metric ton and productivity 15.71 (MoALD 2020). Radish cultivation, February to September is considered as off season, which is followed by regular production during the cool season. During this period (February to September) there is no/or less production of radish in the other parts of that area. The pre-mature bolting in radish is the main problem in the Terai during off season (Pun and Pandey 2004). Off season radish has a lot of opportunities (Pandey 2001). This situation is high potential and an extra advantage for farmers to sell their products at higher prices (Dahal 2019).

Nepal Agriculture Research Council (NARC) has been evaluating radish varieties for different traits. There are several open pollinated and hybrid radish variety seeds are available in the market, having different varietal characters such as root color, taste, length, size, yield potential and quality parameters but there is a lack of information regarding the radish varieties suitable for Rampur, Chitwan condition. The productivity and quality of these different varieties are not yet tested scientifically (Dahal 2019). Hence, in order to study these aspects critically the present investigation was conducted. The main objective of this study was to compare the growth and yield parameters of different radish varieties and to select the suitable varieties for spring season under the net house for plane of Chitwan, Nepal.

MATERIALS AND METHODS

An experiment on Evaluation of radish (*Raphanus sativus* L.) varieties under net house for off season was carried out at the horticulture research farm of Agriculture and Forestry University, Rampur, Chitwan, Nepal during the spring season in the year 2018. Mesh size net of 30 cm was used as boundary and 50% shade net was used as top cladding. The experiment was laid out in Randomize Completely Block Design (RCBD) with four replications. Each replication consists of eight varieties. All the varieties were randomized separately in each replication. The well decomposed farm yard manure (FYM) at the rate of (20 t ha⁻¹) DAP (108 kg ha⁻¹), MOP (83 kg ha⁻¹), half of Urea (85 kg ha⁻¹) and Borax (10 kg ha⁻¹) were applied as basal dose. The remaining half dose of urea (85 kg ha⁻¹) was applied as topdressing in two equal split doses as 20 and 35 days after

sowing. The irrigation was given at an interval of 5 to 6 days depending upon the soil moisture condition and the field was kept free from weeds manually. The evaluated varieties were Vedetar Local, Miyasinge, Tokinasi, Pusa Chetki, Mino Early Long White F1, Ivory White F1, MAHY 22 F and All Season. The seed was shown on the third week of February. Spacing was maintained at 20 cm between rows and 15 cm between plants. Spacing between plants was maintained by thinned out lean, thin, diseased and overcrowded seedlings at 15 DAS and left single vigorous seedling per hill. The observations were recorded on growth and yield parameters at harvesting stage and analyzed at 1% and 5% level of significance by using Statistical Tools for Agricultural Research (STAR), version: 2.0.1, 2014 edition.

RESULTS

Growth parameters

The mean number of leaves per plant and plant height of radish was influenced by the varieties due to the variation in genetic makeup. The mean number of leaves per plant of different varieties was found significantly different at harvest (Table 1). The highest number of leaves per plant was produced by MAHY 22 F1 (20.54) followed by Vedetar Local (20.25) at harvest. The lowest number of leaves per plant was produced by Pusa Chetki (11.05).

The average plant height was found highly significantly different among the treatments at the time of harvesting, the highest plant height (43.91 cm) was recorded in Miyasinge and followed by Tokinasi (32.40 cm). The lowest plant height was recorded in Pusa Chetki (37.08 cm) (Table 1).

The average plant height was found highly significantly different among the treatments at the time of harvesting, the highest plant height (43.91 cm) was recorded in Miyasinge and followed by Tokinasi (32.40 cm). The lowest plant height was recorded in Pusa Chetki (37.08 cm) (Table 1). The difference among the varieties on leaf area per plant was found significantly different. The highest leaf area per plant (1357.24 cm²) was recorded in the Miyasinge followed by Mino Early Long White F1 (1196.79 cm²). The lowest leaf area plant (708.22 cm²) was recorded in Tokinasi.

Fresh weight of leaves per plant at harvest was found significantly different among the variety. The highest mean fresh weight of leaves per plant at harvest (165.40 g) was recorded in Miyasinge followed by Vedetar Local (127.15 g). The lowest fresh leaves weight per plant (50.50 g) was recorded in Tokinasi variety.

Yield parameters

The mean root length, root diameter and root weight were found significantly different among the treatments (Table 2). The highest root length per plant (19.51 cm) was recorded in Ivory White F1

(2.80 cm). The lowest root diameter (2.46 cm) was found in Vedetar Local.

The mean data on the fresh root weight, highest fresh root weight (92.60 g) was recorded in Ivory White F1 followed by MAHY 22 F1 (70.05

Table 1. Growth parameters of different radish varieties at harvesting stages at Rampur, Chitwan, Nepal

Varieties	Growth parameters at harvesting stages			
	Number of leaf plant ⁻¹	Plant height (cm)	Leaf area plant ⁻¹ (cm ²)	Fresh wt. of leaf plant ⁻¹ (g)
Vedetar Local	20.25 ^a	39.90 ^{ab}	981.40 ^{ab}	127.15 ^{ab}
Miyasinge	18.00 ^{ab}	43.91 ^a	1357.24 ^a	165.40 ^a
Tokinasi	18.85 ^{ab}	43.69 ^a	708.22 ^b	50.50 ^c
Pusa Chetki	11.05 ^c	37.08 ^b	956.14 ^{ab}	53.50 ^c
Mino Early Long White F1	19.15 ^{ab}	39.56 ^{ab}	1196.79 ^{ab}	79.50 ^{bc}
Ivory White F1	15.85 ^b	40.41 ^{ab}	872.30 ^{ab}	71.80 ^{bc}
MAHY 22 F1	20.54 ^a	38.60 ^{ab}	1168.65 ^{ab}	81.90 ^{bc}
All Season	16.60 ^{ab}	42.73 ^{ab}	792.81 ^b	79.70 ^{bc}
SEM ±	0.88	1.27	115.22	11.74
HSD (0.05)	4.1819	6.0186	546.5418	55.7077
F-Test	**	**	**	**
CV (%)	10.05	6.23	22.95	26.49

Means with same letter(s) within column do not differ significantly at p=0.05, SEM = Standard error of means, HSD = Honest Significant Difference, CV = Coefficient of variance, ** significant at 1% and * significant at 5% level of significance

followed by Mino Early Long White F1 (18.86 cm) harvest. The lowest root length per plant (11.41 cm) was found in Miyasinge (Table 2). The root length is an important character regarding root quality for consumer acceptability (Dahal, 2019). Highest root diameter per plant (2.9 cm) was recorded in All season followed by Ivory White F1

g). The lowest fresh root weight (35.80 g) was found in Pusa Chetki.

Yield

The difference among the treatments on total fresh biomass (whole plant) yield and fresh root yield at harvest was found significant (Table 3).

Table 2. Yield parameters of different radish varieties at harvesting stages at Rampur, Chitwan, Nepal

Varieties	Root length (cm)	Root diameter (cm)	Root weight (g)
Vedetar Local	12.15 ^{cd}	2.46 ^b	49.80 ^b
Miyasinge	11.41 ^d	2.79 ^{ab}	54.25 ^b
Tokinasi	14.76 ^{bcd}	2.71 ^{ab}	47.00 ^b
Pusa Chetki	15.60 ^{abc}	2.54 ^b	35.80 ^b
Mino Early Long White F1	18.86 ^a	2.75 ^{ab}	69.15 ^{ab}
Ivory White F1	19.51 ^a	2.80 ^{ab}	92.60 ^a
MAHY 22 F1	17.66 ^{ab}	2.74 ^{ab}	70.05 ^{ab}
All Season	16.34 ^{ab}	2.90 ^a	67.05 ^{ab}
SEM ±	0.85	0.0740	7.32
HSD (0.05)	4.0488	0.3511	34.7382
F-Test	**	**	**
CV (%)	10.81	5.45	24.12

Means with same letter(s) within column do not differ significantly at p=0.05, SEM = Standard error of means, HSD = Honest Significant Difference, CV = Coefficient of variance, NS = Non significant, ** significant at 1% and * significant at 5% level of significance

The highest mean biomass yield at harvest (73.22 t ha⁻¹) was recorded in Miyasinge followed Vedetar Local (58.98 t ha⁻¹). The lowest biomass yield (29.77 t ha⁻¹) was recorded in Pusa Chetki. Similarly the highest fresh root was produced by

bolting in any of the varieties during the whole growing period.

Days to maturity

Data respects to the number of days required

Table 3 Yield of different radish varieties at harvesting stages at Rampur, Chitwan, Nepal

Varieties		Root yield (t ha ⁻¹)
Vedetar Local	58.98 ^a	16.60 ^b
Miyasinge	73.22 ^a	18.08 ^b
Tokinasi	32.50 ^b	15.67 ^b
Pusa Chetki	29.77 ^b	11.93 ^b
Mino Early Long White F1	49.55 ^{ab}	23.05 ^{ab}
Ivory White F1	54.80 ^{ab}	30.87 ^a
MAHY 22 F1	50.65 ^{ab}	23.35 ^{ab}
All Season	48.92 ^{ab}	22.35 ^{ab}
SEM ±	5.56	3.45
HSD(0.05)	26.3614	11.58
F-Test	**	**
CV (%)	22.32	24.12

Means with same letter(s) within column do not differ significantly at p=0.05, SEM = Standard error of means, HSD = Honest Significant Difference, CV = Coefficient of variance, NS = Non significant, ** significant at 1% and * significant at 5% level of significance

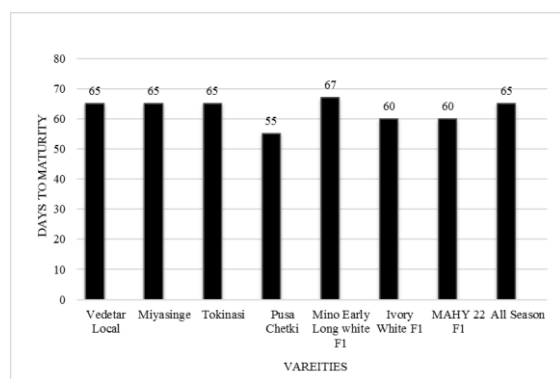


Figure 1. Number of days to maturity of radish varieties

Ivory White F1 at 30.87 t ha⁻¹. Hybrid variety MAHY 22 F1 and Mino Early Long White F1 produced second highest fresh root yield at 23.35 t ha⁻¹ and 23.05 t ha⁻¹. The lowest fresh root yield was recorded in Pusa Chetki at 11.93 t ha⁻¹.

Premature Bolting

Premature bolting is negatively correlated with root yield, which reduces the quality of radish yield and it is a main problem for off-season radish production. The experiment shows no premature

for attaining the edible size were varied among the varieties (figure 1). Pusa Chetki was recorded the earliest (55 DAS) to attain the edible root size followed by Ivory White F1 (60 DAS) and MAHY 22 F1 (60 DAS) whereas the Mino Early Long White F1 (67 DAS), Vedetar Local, Miyasinge, Tokinasi and All Season were recorded maximum days (65 DAS) to attain the edible root size.

DISCUSSION

Premature bolting without root formation is the main problem for spring and summer season radish production in the Terai region of Nepal. Pandey et al. (2017), stated that long day conditions and high temperature influenced in bolting of radish before proper root development. This economic return can increase manifolds if vegetables are grown in protected conditions. Sindhu and Chatterje (2020), state that the productivity of off-season vegetables can increase many fold if the high value vegetables are grown through protected cultivation technologies. It helps to improve yield quantity and quality of the vegetables (Shahak et al. 2008). Vegetable growers farmer achieves distinct advantages of quality, productivity and favorable market price of fresh

vegetable through the protected cultivation (Singh and Sirohi 2004).

The consumer selects the radish root which has appropriate root length and diameter. Root shape and size influence the market price of the product (Reid and English 2000). Growth, yield and quality characters of radish are governed by the genetic makeup of the varieties as well as the growing environment (Tsuru et al. 2008). The variations in growth (Table 1), yield character (Table 2) and yield (Table 3) among these eight varieties may be considered as varietal difference, as all these varieties are tested under same soil, management and similar agro-climatic conditions. The highest number of leaves per plant (20.54) was recorded in MAHY 22 F1. The variation in the numbers of leaves per plant among different radish varieties was also reported by Ola et al. (2018). Similar result was reported by Dahal (2019). The highest plant height (43.91), leaf area per plant (1357.24 cm²) and fresh weight of leaf per plant (165.40 g) was recorded in variety Miyasinge. The variations in leaf area among different varieties of radish might be attributed to their inert characters of these varieties and growing environment. The maximum leaf area might support for more photosynthesis, which leads to maximum yield. The fresh weight of leaf per plant (g) was positively correlated with no of leaves per plant, plant height and leaf area per plant (Panwar et al. 2003). Similar results were obtained by Mallikarjunarao et al. (2015). The variations in growth parameters among different varieties was also reported by Chapagain et al. (2010), Mallikarjunarao et al. (2015); Priyanka et al. (2018); Dongarwar et al. (2018); and Dahal (2019) which confirms the results of the present investigation.

The significant variations in yield parameters were found from the evaluation of various radish varieties (Table 2). The highest root length (19.51 cm) was recorded in Ivory White F1 while the highest root diameter (2.90 cm) was recorded in Miyasinge followed by Ivory White F1 (2.80 cm). The highest root weight (90.60 g) was recorded in Ivory White F1. Root yield is positively correlated with the root length and diameter of the root and root weight (Dahal 2019). The variations in fresh root weight among different radish varieties might be due to the varietal difference (Zheng et al. 2008). These variations of root length was reported by Subedi et al. (2018), who also found the highest root length in variety Mino Early Long White F1 (23.56 cm), Dahal (2019) reported highest root length in Ivory White (20.76 cm) in an open field for the spring season. These variations of root length also reported by Kumar et al. (2012).

Differences in yield among the cultivars may be due to genetic factors and their interaction to the

environmental conditions. The variations in yield among these eight varieties (Table 3) may be considered as varietal difference, as all these varieties are tested under same soil, management and similar agro-climatic conditions. The highest biomass yield (73.22 t ha⁻¹) was recorded in Miyasinge and the highest fresh root (30.87 t ha⁻¹) was recorded in Ivory White F1.

The variations in yield among the radish varieties were also reported by several workers (Thorat et al. 2015, Dongarwar et al. 2018, Subedi 2018 and Dahal 2019). The variations in yield among these varieties may be considered as varietal difference due to genetic factors and their interaction to the environmental conditions, as all these varieties are tested under same soil, management and similar agro-climatic conditions inside the net house. Hence, the results of the present investigation are in line with the findings of earlier workers.

Premature bolting of radish negatively correlated with root yield. No bolting was observed in all the varieties during the whole growing period. In net-house condition, the crop is covered by a porous screen, which prevents excess heat Malik (2016), also reported that mulched radish bolted later as compare to non-mulched ones.

The differences in maturity period can govern by genetic differences among the varieties and climatic as well as the ecological condition of crop growing area. Sing and Karmakar (2015), reported that the number of days to edible size for different radish varieties ranged between 40 to 54 days (Figure 1). The similar variations in day to maturity among different varieties was also reported by Chandel et al. (2015), Dongarwar et al. (2018).

CONCLUSIONS

In general, radish cultivation in plain areas of Nepal is not suitable for spring and summer because of premature bolting before edible size root formation. Hence, this experiment was conducted under net house conditions, different varieties of radish were evaluated. The results suggested that Ivory White F1 variety can be cultivated under net house in Chitwan. So this technology should be recommended to farmers. As it can give better productivity and higher income.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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