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Enhancing productivity of *kharif* onion for Bundelkhand region

Onion is widely cultivated for internal consumption as well as for the export. India is the major onion-producing country in the world. At regular intervals, onion makes us cry by its high price fluctuations and gap between supply and demand. Therefore, it is high time to take the privilege to divert mass for cultivation of onion in *kharif* season by using simplest technological interventions. As the climate of Bundelkhand region matches with climate of Deccan plateau where *kharif* onions are being grown over the years, therefore, we also want to take advantage of ecological boundaries and to disseminate the cultivation at large scale under participatory production programme. As of now, we have already shortlisted the most prominent variety of onion namely, Line-883 from the available pool which matures as early as by 80-82 days and produces 25-30 tonnes of bulb yield under poor resource conditions. These prominent lines/varieties need large dissemination at grass route level. This certainly will change the socio-economic conditions of small and marginal growers and generate employability to the rural landless farmers of the region that can help to restrict seasonal migration of the labours.

ONION is one of the most important vegetable crops grown in India having both food and medicinal values, and widely cultivated for internal consumption as well as for export. It is an important crop of India grown in 12.85 lakh hectare area with production of 232.62 lakh metric tonnes across diverse climatic conditions in the country. The national as well as regional productivity of onion is very low (18.10 tonne/ha). Onion is used as spice, condiment and vegetable almost daily in every kitchen as a seasoning for wide varieties of dishes. The green leaves, immature and mature bulbs are eaten raw as well as in preparation of vegetables. Because of its special characteristics of pungency, it has more value than other vegetables. It is very perishable crop, and cannot be stored for long time. It has very good export potential and demand of onion increased day-by-day for export as well as internal consumption of the country. Because of its high export potential, it comes under cash crop apart from vegetable.

Bundelkhand region comprising Banda, Chitrakoot, Mahoba, Hamirpur, Jhansi, Lalitpur, and Jalaun districts of Uttar Pradesh lag behind other regions of the country in terms of various economic indicators. Over the years, horticulture has emerged as one of the potential agricultural enterprise in accelerating the growth of economy. The horticulture sector encompasses a wide range of crops e.g. fruit crops, vegetable crops, potato and tuber crops, ornamental crops, medicinal and aromatic crops, spices and plantation crops. Bundelkhand with its wide variability of climate and soil is highly favourable for growing a large number of horticultural crops. It contributes in poverty alleviation, nutritional security and have ample scope for farmers to increase their income and helpful in sustaining large number of agro-based industries which generate huge employment opportunities.

The area and production in seven districts of Bundelkhand region of Uttar Pradesh (Chitrakoot, Banda, Hamirpur, Mahoba, Jalaun, Jhansi and Lalitpur) is 1120 hectares and 20280 metric tonnes, respectively. Poor productivity of this crop may be due to many reasons including lack of region-specific high yielding varieties, improved production packages and quality seeds. In recent years, a large number of varieties and hybrids have been developed by National Institutes like Directorate of Onion and Garlic Research, IIHR, NHRDF, IARI, besides State Agricultural Universities like MPKV for cultivation in a wide range of agro-climatic conditions of the country in different seasons. However, a few or no variety has been developed specifically for Bundelkhand region. However, onion were evaluated at this centre and some varieties were identified such as L-883, Bhima Shweta, Agrifound Dark Red, Bhima Super, etc. which are grown by the farmers of this region using agro-techniques developed by institute which fetches more money enhancing their income and socio-economic status. Like Andhra, Telangana, Karnataka, Maharashtra, major part of Madhya Pradesh, and Bundelkhand region of Uttar Pradesh is suitable for onion cultivation during *kharif* seasons.

Selection of varieties

The selections of high yielding *kharif* onion varieties are the important factor to improve the income and socio-economic status.

Line-883: The plant is straight with erect green leaves and number of leaves per plant is about 6-9. Dark red bulb colour, globular round shape, thin neck and 5.0-5.75 cm, bulb diameter. The average weight of 20 bulbs is about 1.00-1.35 kg. Total soluble solid and dry matter content is about 12.5-13% and 13-14%, respectively. The variety is accepted by farmers because of its higher yield and better adaptability. Matures in 80-90 days after transplanting. In case of broadcasting of direct seeds in fields in Gujarat, Karnataka and Madhya Pradesh areas, it matured in only 80-85 days with good and compact bulbs. Tolerant to foliar diseases likes purple blotch and stemphylium blight under field condition. Average yield is about 25-32.5 t/ha.

Agrifound Dark Red: Bulbs are dark red in colour, globular in shape with tight skin and moderately pungent. Bulb diameter is 4-6 cm. Total soluble solid 12-13% and pyruvic acid 10.07 micro mol/g. It is also suitable for bulblets production for early *kharif* crop. Matures in 90-95 days after transplanting. Average yield 300 q/ha, keeping quality average and recommended for *kharif* season all over the country.

Bhima Shweta: Onion variety is released for *kharif* in Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and Tamil Nadu. Matures within 110-120 days after transplanting. It has medium keeping quality and can be stored up to 3 months. Average marketable yield during *kharif* season is 18-20 t/ha.

N-53: Bulbs are red, flattish round in shape, medium to large and mildly pungent. Bulbs mature 90-100 days after transplanting. Keeping quality is poor. Total soluble solid (11-12%). Average yield (250 q/ha). Recommended for *kharif* season in all zones in India

B-780: Bulbs are crimson red, globe in shape, mildly pungent, less bolting and twins. Bulbs mature 100-110 days after transplanting. Keeping quality is average. Total soluble solid (12%). Average yield (250 q/ha). Recommended for *kharif* season in zone VI.

Phule Samarth: Bulbs dark red, globular round shape, thin neck. Bulbs matures 100-110 days after transplanting. Keeping quality is medium. Average yield (200-250 q/ha). Recommended for *kharif* and early-*rabi* (*Rangda*) seasons in zones IV and V.

Bhima Super: Bulbs dark red, oval in shape and thin neck. Bulbs mature 120-125 days after transplanting. Keeping quality is average. Total soluble solid (10-11%). Average yield (250-300 q/ha). Recommended for *kharif* season in zones VI, VII, and VIII.

Bhima Red: Bulbs are attractive red with round shape. Bulbs matures 100-120 days after transplanting. Total soluble solid (10-11%). Average yield (250-300 q/ha). Recommended for *kharif* season in zones VI, VII, and VIII.

Bhima Raj: Bulbs are round with tapering neck. Bulbs mature 110-115 days after transplanting. Total soluble solid (10-11%). Average yield (200-220 q/ha) in *kharif* and (400-450 q/ha) in late-*kharif*. Recommended for *kharif* and late-*kharif* season in zones VI, VII, and VIII.

Bhima Dark Red: Bulbs are attractive dark red, globular bulb. Bulbs mature 95-100 days after transplanting. Total soluble solid (11-12%). Average yield (200-220 q/ha). Recommended for *kharif* season in zones II, IV, V and VI.

Raised bed nursery preparation for healthy seedlings

Onion seed is generally sown in raised nursery bed (15–22 cm height) for transplanting in the field. The width of nursery bed should be 0.70-0.80 m and length can be kept 3–4 m. The distance in between two beds should be kept about 45–50 cm. The surface of beds should be smooth and well leveled. June-July is the best time for *kharif* in the plain all over the country. Sowing of onion seeds should be done in lines in proper spacing at 5-7 cm row distance. Before sowing, seed should be treated with thiram @ 2.0 g per kg of seeds to avoid damage of seedlings from damping-off disease. The soil of nursery should also be treated with thiram or captan @ 4-5 g per meter square area. The nursery soil should be irrigated 15-20 days, before sowing and covered with 250-gauge transparent polythene for soil solarization. The application of *Trichoderma viride* fungal culture @ 1250 g/ha is also recommended to manage damping-off and raising the healthy nursery. *Trichoderma viride* should be mixed in 25 times decomposed sieved FYM or sieved moist soils for application in field. To check post-emergence damping-off, drenching of the nursery with 0.1% Brassicol/copper oxychloride or 0.2% Captan should be done. The seeds after sowing should be covered with fine powdered FYM or compost followed by light watering by water can. After that beds should be covered with dry straw or grass or sugarcane leaves to maintain required temperature and moisture called mulching. The watering should be done by water can as per the need till germination completes. The mulching materials should be removed immediately after germination completed. Any delay in removal of mulch, will results in lanky seedlings. The nursery will be ready for transplanting when plants are 6-7 weeks old for *kharif* 7-8 kg seeds for common big onion are sufficient for one hectare. Bhonde *et. al.* (1987) recommended 30th August transplanting for *kharif* onion production in Nasik area.

Bhima Super L-883 Agrifound Dark Red

High yielding onion varieties for doubling the income of farmers

Nursery preparation, sowing of seed and healthy nursery

Preperation of beds

Sowing of seeds in nursery beds

Excellent germination of onion seeds

Healthy root growth showed potential of onion in Buldelkhand region of Uttar Pradesh

Production of excellent quality Bulblets for quality onion

Healthy germination of onion seeds

Bulblets of onion variety ADR

Bulblets of onion variety L-883

Bulblets of onion variety Bhima Super

Bulblets of onion variety Bhima Dark Red

Bulblets of onion variety Bhima Shweta

Technique for raising small bulblets for production of quality bulb

In Bundelkhand region, the pattern of rainfall is very erratic. Sometimes during monsoon period the intensity of rainfall is very high for very short period which damages the *kharif* onion nursery. To avoid the erratic rains, setts preparation is the technique for quality onion production in *kharif* season for increase the income of farmers of Bundelkhand region.

The bulblets raised from *kharif* onion varieties, Agrifound Dark Red, Baswant-780, N-53 and Arka Kalyan and Bhima Dark Red in previous season are used for planting. Seeds are sown on raised beds @ 6-8 g/m^2 or in flat beds depending upon the soil. The best time of sowing of seeds for getting quality bulblets is mid-January to early-February. All other operations for raising of bulblets are the same as that of nursery for transplanting. The plants are allowed in nursery beds up to April-May till there is top fall. Harvesting is done along with the tops; selected bulblets (1.5-2.5cm) are stored by hanging method till August in a well-ventilated room/ godown. Large-sized bulblets result in more doubles and bolters, increasing cost of production. It is experienced that average weight of 100 bulblets size $<$ 1.5 cm, 1.5-2.0 cm and $>$ 2.0 cm are about 310 g, 520 g. and 920 g, respectively. Planting of more than 2.0 cm bulblets in one hectare requires five lakh bulblets, (about 40 q/ha). However, if size of bulblets is 1.5-2.0 cm, it might require 26 q/ha. Planting of bulblets on raised beds or on both sides of ridges in BBF (Broad Band Furrow) system is recommended for better bulb development and yield. July-August is best time of planting in Maharashtra and August in northern states. Bed size depends upon level of land, soil type and irrigation method. Planting of oversize bulblets increases bolting and reduce the quality of the produce. Dipping of bulblets in Carbendazin @ 0.1% and Monocrotophos @ 0.1% solution before planting, helps in better establishment of bulblets. Planting is done at 15 cm from line-to-line and 10 cm from plant-to-plant, i.e. 15 cm × 10 cm spacing. Cultural operations for quality bulb production are the same to those of common onion bulb production.

Application of manures and fertilizers

The soil for onion growing should be liberally manured and fertilized. Application of 20-25 tonnes of FYM/ha in soil is considered adequate. The chemical fertilizers such as 100 kg N, 50 kg P, 50 kg K and 30 kg S is required for production of good quality bulbs. Farm Yard Manure should be applied one month before transplanting/planting or sowing, and mixed well in the soil. Whole quantity of phosphorus, potash, sulphur and half of nitrogen should be mixed in the soil before transplanting. Rest half doses of nitrogen should be given as top dressing in two equal split doses, first dose should be applied at 30 days after transplanting whereas second dose at 45 days after transplanting. The top dressing must be completed before initiation of bulbing. Delayed application results in thick neck or doubles. The application of polyfeed (19:19:19:TE) @ 1% at 15, 30 and 45 days as foliar sprays and multi-K (13:0:46) @ 1.0% at 60, 76, and 90 days have improved yields as well as storability in onion. The highest bulb yield (22.7 t/ha) with 40 tonnes of FYM and biofertilizer

inoculation along with NPK, thereby saving 25% on nitrogen alone. The application of FYM @ 15 t/ha + *Azotobactor* seedling dip and Nimbicidin application indicated a possibility of replacement of inorganic fertilizers under organic farming. 2 kg/ha of *Azospirillum* and Phosphobacteria with 45 kg N and 45 kg P was more remunerative compared to 60: 30: 30 kg of NPK/ha.

Transplanting and water management

Seedlings are usually transplanted in raised beds. 6-7 weeks old seedlings are recommended for *kharif* season crop. If over-aged seedlings are planted, bolting increases while for younger seedlings, establishment will be poor. For *rabi* the best time of transplanting, in Northern and Eastern India is end of December to first week of January. Dipping of seedlings root in fungicides (carbendazin @ 0.1%) and insecticide (monocrotophos @ 0.1%) solution before transplanting helps in better establishment of seedlings. The spacing depends upon the variety and size of the bulbs. In common, big size onion 15 cm from line to line and 10 cm from plant to plant is considered to be the best spacing. For raised bed planting method, spacing of 10 cm × 10 cm to 12 cm × 10 cm in trend is more suitable for higher yield and storability of bulbs. The irrigations depend on several factors such as crop growth, soil type and planting season. Onion is shallow rooted crop. Its root system is normally restricted to top 3.0 cm and roots penetrate seldom deeper than 15 cm. The water requirement of the crop at the initial growth period is less. The irrigation interval of 15 days in *rabi* onion up to 60 days and 8 days afterwards gave better results.

One irrigation is necessary immediately after transplanting particularly in rainy season in Northern India where temperature at the time of transplanting is very high. It has been experienced that if irrigation is delayed due to some reasons there is 80-90% mortality. At bulb formation, irrigation is necessary and moisture stress at this stage results in low yield. It is reported that onion cultivar CO-4 to be irrigated at IW/CPE values of 0.6, 0.8, 1.0 or 1.2 during *kharif* and summer seasons. Bulb yield increased as IW/CPE value increased. Water use efficiency was greatest when onion was irrigated at IW/CPE of 1.2. Irrigation at 3-day intervals significantly affected number of leaves per plant, plant height at maturity, bulb yield, bulb weight, number of cloves per bulb and clove weight, while, increase in number of days between irrigation intervals negatively affected growth and yield. Among the irrigation methods evaluated, drip irrigation at 100% PE recorded the highest marketable bulb yield in both the crops with 30-40% water saving in comparison with surface irrigation.

Weed management and micronutrients spray

Being closely planted and a shallow rooted crop, hand weeding, particularly when crop is in full vegetative stage, is difficult. Many times, because of shortage of labour, it is difficult to manage weeds manually. Further it is expensive too. Therefore, it is recommended to use weedicide along with one hand weeding at critical stage. Use of stomp @ 3.5 L/ha applied 3 days after transplanting plus one hand weeding at 45 days gave better results. Oxyflurofen (goal) @ 1 ml/L spray after 3 days planting is very effective with one hand weeding is also found very effective. Spray of cytozyme @ 0.2% spray at 15 and 45 days after transplanting are found effective. Seedlings root dip for 20 min before planting and foliar sprays are found more effective in bulb development and higher yield. The application of bio-algeen, a sea weed product as seedling sprays @ 2 ml/L, as root dip @ 0.5% and as foliar sprays @ 5 ml/L at 30, 45 and 60 days after planting gave significant yield. Another report, Goal (Oxyfluorfen 23.6%) at 0.75 L/ha applied 3 weeks after transplanting or Stomp Pendimethalin 50% at 2.0 L applied after transplanting and before irrigation gave the best control, resulting in highest bulb yield.

Harvesting, drying, curing and yield

Development of red pigment and the characteristic pungency of the variety are also important harvest indices of onion. Best time to harvest is when bulb attain full size and mature as per variety, the leaves gets yellow because in *kharif* season neck fall does not take place. The leaves are cut leaving about 2.0-2.5 cm tops above the bulb after complete drying. Curing is an additional process aiding the development of skin colour and also it is practiced to remove field heat before bulbs are stored. Bulbs are cured in field for 3-5 days in windrow method. In *kharif* season late harvesting results in doubles and bolting. Yield is about 25-30 tons/ha.

The purpose of drying is to remove excess moisture from the outer skin and necks region of onion in order to reduce the infection of disease-causing organisms, while minimizing the shrinkage caused by removal of moisture from the interior. Curing is an additional process aiding the development of skin colour and also it is practiced to remove field heat before bulbs are stored. Wherever temperature is low, bulbs are cured artificially by-passing hot air at 46^{0}C for 16 h. Bulbs should be brought in shade and cured for 7-10 days to remove the field heat. The curing in shade improves bulb colour and reduces losses significantly during storage. Curing for 10-12 days in shade helps in development of more, number of skin and also their retention for longer period.

Management of diseases and insects

In Purple blotch caused by *Alternaria porri,* typical eye-shaped symptoms appear on leaves and flower stalks as small, sunken, whitish flecks with purple colored centre. Fungicides such as Mancozeb @ 0.25% or Chlorothalonil @ 0.2% or Iprodion @ 0.25% should be sprayed at

Table 1. Estimation of *kharif* onion Benefit: cost ratio

Cost of Input/ha (₹)	Yield q/ ha	Approx. sale rate of onion per kg	Price of marketable produce (₹/ha)	Net return (₹/ha)	Cost-Benefit Ratio
90,000/	225	20/-	4,50,000/-	3,60,000/-	1:4

fortnightly interval. Stemphylium blight caused by *Stemphylium vesicarium* occurs on radial leaves of seedlings at 3-4 leaf stage. Infection appears as small yellow to pale orange spots or streaks in middle of leaves on inner side and flower stalks. Spraying of fungicide such as Mancozeb @ 0.25% or chlorothalonil @ 0.2 % along with insecticides deltamethrin (Decis) @ 0.10% and sticker at fortnightly interval. Thrips *(Thrips tabaci)* is very minute yellow to dark brown in colour and life of insect is 8-10 days. It is found in the axil of green leaves where it sucks juice of early emerging leaf. The infected plants show stunted growth with twisted leaves. Infestation comes in early stage of the growth; the bulb formation stops completely and plants die slowly. Metasystox @ 0.1% and cypermethrin @ 0.01% or deltamethrin 2.8 ai @ 20 ml/ha should be sprayed along with triton or sandovit.

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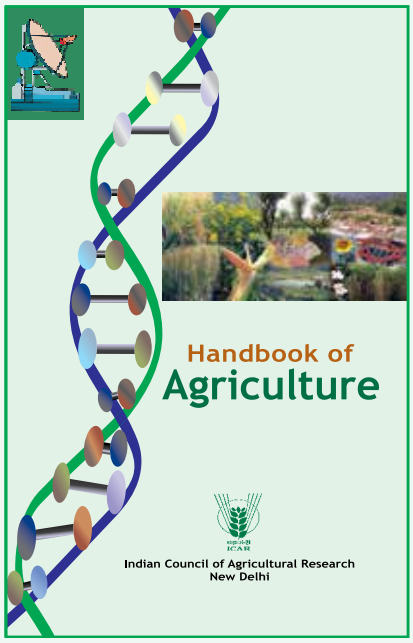

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TECHNICAL SPECIFICATIONS

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