SEED PRODUCTION IN PEARL MILLET

Bajra is common minor millet of India with wider industrial and household utility. It is used a feed, food and raw material in soft drink industry. Botanically it is known as *Pennisetum typhoides* L. and belongs to the family poaceae.

Floral biology

It is a highly cross-pollinated crop. The pollinating agent is wind. The flowers are protogynous. The spike emerges about 10 weeks after sowing, The styles begin to protrude 2-3 days later first at the top of the inflorescence and proceeds. They take two days to complete the entire spike. Exerted stigma remains receptive for 12-24 hours. Anthers usually emerge after the styles are dry. The anther emergence starts from middle of the spike and proceeds upwards and downwards. Anthesis occurs throughout the day and night with the peak between 8.00 p.m. to 2.00 a.m.

Protogynus

Stigma Anther

Popular variety : co7, co 8

Synthetics : If more than 5 parental lines are combined ,which are having general combining ability e.g. CO 7, ICMS 7703

Composite: 3-5 inbreds with no general combining ability are mixed and multiplied. WCC 75.(ICRISAT).

Land requirement

Seed field offered for certification should not have been grown with bajra in the previous season. However if it was grown, the field should be irrigated 3 weeks before sowing to destroy the germinating seeds.

Field Standards for isolation

Bajra field should be isolated from contaminants as follows

Contaminants	**Minimum distance(m)**	
	Foundation stage	**Certified stage**
Fields of other varieties	400	200
Fields of same variety not confirming to varietal purity requirements for certification	200	100

In bajra differential blooming dates for modifying the isolation distance is not permitted

Selection of Seed

- ✓ For production of foundation seed, breeder seed is used as the base material while for certified seed, foundation seed should be used as the base material .
- ✓ The seed used should be from authenticated source with tag and bill.
- ✓ The required seed rate will be 18kg /ha or 3-4kg/ acre.

Presowing seed treatment

- ✓ The seeds are given with any one of the seed treatment or in combination.
- ✓ Seeds are soaked in 2% KH_2PO_4 or 0.5% brassinolide for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture

content of 8-9% .This management could be used both for dryland agriculture as well as garden land.

- ✓ As an ecofriendly treatment seeds are also fortified or hardened with 1% *prosopis* and pungam leaf extract for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9%
- ✓ Seeds are treated with metalaxyl @6g/kg of seed to prevent the infestation by downy mildew.
- ✓ Seeds are also treated with 5% carbofuran 3G to protect the seed from shoofly infection. Seed treatment with chlorpyriphos @4 ml /kg is also recommended against the attack by shoofly.
- ✓ Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen.
- ✓ Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N. Any one of these treatment or combination of treatment is adopted for better productivity.
- ✓ On adoption of sequence of treatment physiological should be followed with physical seed treatment.

Sowing

- ✓ The seed are sown at a spacing of 45 x 20 cm at a depth of 2-4cm as the plant has adventitious root system.
- ✓ In some places seeds are also raised in nursery and transplanted to the main field at an age of 20 -25 days.
- ✓ In the main field seeds are sown either in ridges and furrows or under beds and channels.
- ✓ The seedlings are thinned or transplanted at 20-25 days after sowing and gapfilling should be done 10-15 days after sowing.

Nutrient application

- ✓ At last ploughing apply 12.5 tonnes of compost per hectare. The fertilizer requirement of seed crop is 100:50:50 kg of NPK, in which 50:50:50 kg /ha of NPK is applied as basal, while 50kg of N is applied after 30-35 days after sowing at tillering phase .
- ✓ The seed crop is also sprayed with 2% DAP at primordial initiation stage and twice thereafter at 10 days interval to enhance uniform flowering and increased seed set.

Weeding

Application of atrazine @ 10ml per litre as pre-emergence herbicide controls the growth of weeds upto 20-25 days. One hand weeding at the time of primordial initiation keep the field free of weeds. Weeding after boot leaf stage is not economical and shade will also minimize the weed flora. On organic production, 2 hand weeding at seedling stage and other at boot leaf formation will keep the field weed free.

Irrigation

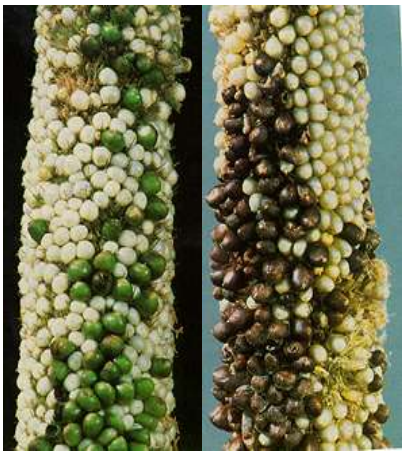
- ✓ The crop should be irrigated once in a week for enhanced seed set and formation of bolder grains .
- ✓ The critical stages of irrigation are primordial initiation stage, vegetative stage ,milky and maturation stage. If the irrigation is withheld in these stages seed set will be poor and seed size will be reduced.

Pest and disease management

Common pests	Management techniques
Shootfly	Monocrotophos 0.03%
Stemborer	Rogar 0.3%
Downy mildew	Metalaxil @ 500gor ridonil MZ WP 2@2kg/ha Mancozeb@ 1kg/ha.

Earhead bugs	Endosulphan 0.07%
Black mould	Endosulphan 0.07% + Bavistin @10g /lit.
Green ear /Smut/Ergot	Spray carbendazim @500g/ac in 2stages 10 and 50 flowering
Rust	Spray with wettable sulphur @2.5g/ha on initiation symptom and 10 days thereafter..

Green ear **Smut** **Ergot**


Roguing

It is specific to seed crop and is done from seedling stage to harvesting stage based on the phenotypic characters. Off types can be identified through stem colour, plant structure, number of leaves, auricles, nodal colour, grain colour etc. The field standard for seed crop is as follows

Specific standard: These are verified at the final inspection

Factor	**Maximum permitted (%)**	
	FS	**CS**

Off types at any one inspection and after flowering	0.050	0.10
Plants infected by downy mildew/ green ear disease any one inspection	0.050	0.10
Ergot earheads at final inspection **	0.020	0.040
Earheads infected with grain smut at final inspection	0.050	0.100

** Even if the infection is within the limit seeds are graded with brine solution to become eligible for certification.

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering preferably within 30 days after planting in order to verify isolation, volunteer plants, off types, downy mildew incidence and other relevant factors.

2. The second inspection shall be made during 50% flowering to check isolation, off types, downy mildew incidence /green ear and other relevant factors

3. The third inspection shall be made at maturity and prior to harvesting and in order to determine the incidence of downy mildew /green ear disease, ergot, grain smut and to verify true nature of plant and other relevant factors

Pre harvest sanitation spray

Spraying of endosulphan @ 0.07% and bavistin@10g /lit 10 days prior to harvest prevent the seed weevil (*Sitophilus oryzae*) infestation at storage.

Harvesting

The crop attains physiological maturity 30-35 days after 50% flowering and the seed moisture at this stage will be around 25-30%. This stage can be easily be identified by the formation of dunken layer at the place of attachment to the ear head. The ear heads are harvested when 80 % of the ear heads are physiologically matured, where the moisture content will be around 20 %.The crop is commercially harvested as once over harvest but harvesting of ear heads as 2or 3 picking will

preserve the seed quality as matured seeds are not over exposed to the changes in environmental conditions.

Special techniques

Selection of first formed 5-6 tillers for seed purpose ensures seeds quality. Ear heads also exhibit positional polymorphism where seeds of middle are better in seed quality. This type of selection will be useful in long term storage of seeds

Threshing

The ear heads are dried under sun and threshed with fliable stick for extraction of seeds. The moisture content of seed at the time of threshing will be 15-18%.On large scale production LCT threshers are used, but care should be given to avoid mechanical damage, which in turn will reduce the seed quality and storability.

Drying

The seeds are dried to 8 to10 % moisture content either under sun or adopting mechanical driers for long term storage as the seeds is orthodox in nature.

Processing

Mechanical grading can be done with cleaner cum grader, which will remove the undersized immature and chaffy seeds .The middle screen size should be 4/64" round perforated sieves. The size can vary depending on the variety. (For WCC 75 5/64"sieve is used).

Seed yield: 3500- 4000 kg/ha

Seed treatment

The seeds are infested with several storage pests, to protect against these pests the seeds are given protective treatment with bavistin @2g/kg of seed with carbaryl @200mg/kg of seed as slurry treatment. Bifenthrin @5mg /kg of seed is also recommended for better seeds storage

Seed packing

Seeds are packed in gunny bag for short term storage while in HDPE and polylined gunny bag for long term storage.

Storage

The treated seed can be stored up to 12 months provided the seeds are not infected with storage pests. Seed can be stored up to 3 years if the seeds are packed in moisture containers and are stored at low temperature .The godown should be kept clean as the possibility of secondary infestation with Trifolium (red flour weevil) is much in these crop. The major problem in storage is incidence of grain weevil which will powder the seed material in a short period.

Seed standard

The processed seed should have the following seed quality characters both for certification and labeling.

Seed Standard

Factor	**Standards for each class**	
	FOUNDATION	CERTIFIED
Pure seed (maximum)	98.0%	98.0%
Inert matter(maximum)	2.0%	2.0%
Other crop seed (maximum)	10/kg	20/kg
Weed seed	10/kg	20/kg
Ergot, sclerotia, seed entirely or partially modified as sclerotia, broken or ergotted	0.020% (by number)	0.040% (by number)

seed (maximum)		
Germination (Minimum)	75%	75%
Moisture (maximum)	12.0%	12.0%
For vapour proof container (maximum)	8.0%	8.0%

Mid storage correction

The seeds loose their quality during storage due to deterioration and pest infestation, when the germination falls below 5-10 % of the required standard the seeds are imposed with midstorage correction, where the seeds are soaked in double the volume of 10-4 M solution of potassium dihydrogen phosphate (3.6mg/lit of water) for 6 hours and the seeds are dried back to original moisture content (8-9%).

HYBRID SEED PRODUCTION

Breeding Technique for hybrid seed production : Cytoplasmic genetic male sterility system (CGMS)

History of bajra hybrid Seed production : The first report on CGMS line was made by Burton and his co workers at Tifton Georgia USA. The line is Tift 23A.

Popular hybrid

Hybrid	Female	Male
KM 1	MS 5141 A	J 104
KM 2	MS 5141 A	K 560 -D-230
X4	MS 5141 A	PT 1921

X5	PB 111A	PT 1921
X6	732 A	PT 3095
X7	111A	PT 1890
H B1	Tift 23A(USA)	BIL -3B
HB 3	Tift 23A(USA)	J 104
HB 5	Tift 23A(USA)	K 559
UCH 11	732 A	PT 3075 (TNAU)
COH(cu) 8	732 A	PT 4450

Commercial Hybrid Seed Production

Isolation	:	Foundation seed : 1000 m Certified seed : 200 m
Season	:	Irrigated : March – April, June - July January – February Rainfed : October – November
Seed rate	:	A line : 6 kg ha^{-1} B line : 2 kg ha^{-1}
Main field preparation	:	Ridges and furrows
Planting ratio	:	Foundation Seed : 4 : 2 Certified Seed : 6 : 2 Pusa 23 - 8 : 2
Border rows	:	Foundation Seed : 8 (B line) Certified Seed : 4 (R line)
Spacing	:	A line : 45 x 20 cm B line : 45 x solid row.
Nursery	:	Seedling can also be raised in raised bed nursery and can transplanted to the main field at 20-25 days of aging.

Manures & Fertilizers

Nursery : 750 kg / 7.5 cents for transplanting in one ha.

Mainfield : Compost : 12.t ton/ha NPK 100:50:50 kg ha^{-1}

Basal : 50:50:50 kg ha^{-1}

Top : 50:0:0 kg ha^{-1} (At tillering phase

Foliar spray : DAP 1% at peak flowering to enhance flowering and seed set.

Steps for synchronization of flowering

- Withholding irrigation
- Application DAP 1%
- Staggered sowing
- Jerking

Jerking

It is done 20-25 days after transplanting or 30-40 days after direct sowing. The early formed earheads of the first tillers are pulled out or removed which will result in uniform flowering of all the tillers.

Specialty with bajra in synchronization

The synchronization problem is less in bajra due to

- Tillering habit
- Supply of continuous pollen
- Lesser pollen weight
- Flight capacity of pollen
- Pollen viability & stigma receptivity are longer.

Roguing : Done in both lines

- A line : seek for offtypes pollen shedder and partials
- R line : Seek for early flowering plants, rouges and diseased plants.

Character of offtypes : Variation in leaf colour, leaf waviness, grain colour earhead, shape, size, etc.

No. of field inspection : Three

- Seedling stage
- Tillering stage
- Grain formation stage.

Field standards

Standards	Maximum permitted (%)	
	FS	CS
Offtypes	0.05	0.10
Pollen shedders	0.05	0.10
Downy mildew diseased plants	0.05	0.10
Earheads affected by ergot	0.02	0.04

Harvesting Technique :

- Due to tillering habit, harvest the panicle / earhead in 2 picking (to avoid delayed harvest)
- Select 5-7 tillers for seed purpose.

Processing :

- Grade with 4/64” round perforated metal sieve as middle screen
- Use OSAW cleaner cum grader

Seed Treatment : Thiram / Bavistin @3g kg^{-1} seed

Seed storage : • Cloth bag for short term storage (12 months)
• 700 gauge polyethylene bag – long term storage (> 24 months)

Mid storage correction : HDH with Na_2PO_4 10^{-4}m for 4h.

Seed standards

Standards	Permitted (%)	
	FS	**CS**
Physical purity (Maximum)	98	98
Inert matter (Maximum)	2	2
Other crop seed (Maximum)	10 / kg	10 / kg
Weed seed (Maximum)	10 / kg	10 / kg
Ergot effected seeds (Maximum) by number	0.020 %	0.040%
Germination	75	75
Moisture content - Moisture pervious Moisture impervious	12 5	12 5

Seed yield : 3200 - 3250 kg / ha